The VGP News, page 450

EOS
Transactions, American Geophysical Union
Vol. 64 No. 28 July 12, 1983

EOS, Transactions, American Geophysical Union Vol. 64, No. 28, Pages 449–456

Particles and Fields—Magnetosphere

IUGG Quadrennial Report Overviews

U.S. National Report to IUGG 1979–1982

Eos is periodically publishing the 13 overviews appearing in the *U.S. National Report to the International Union of Geodesy and Geophysics 1979–1982*. The U.S. National Report was published by AGU on behalf of the U.S. National Committee in four extra issues of *Reviews of Geophysics and Space Physics* (RGSP). The discipline overviews appearing here were published with their associated papers (see Contents list at the end of the each overview).

Subscribers to RGSP will automatically receive the four extra RGSP issues containing the U.S. National Report, which were mailed in June 1983. The four regular issues of RGSP are appearing as usual in February, May, August, and November. Those who do not subscribe to RGSP can still obtain the entire U.S. National Report by entering a subscription to RGSP. In addition, the report of each discipline is automatically mailed separately to those members of AGU for whom that discipline is their primary AGU section affiliation; this separate distribution is made possible by grants from the Defense Mapping Agency, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and U.S. Geological Survey.

Hydrology 1979–1982

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The quadrennium 1979–1982 produced notable advances in surface water and groundwater hydrology, as well as important trends toward a more scientific basis for engineering hydrology. Examples of these developments will be given below, as well as an assessment of current trends.

One of the most significant areas to emerge during the last quadrennium is stochastic groundwater analysis. The basis for the conceptualization of groundwater flow and transport as a stochastic process is twofold: (1) the realization that hydrologeological environments are extremely heterogeneous, regardless of the scale of modeling or data collection and (2) the use of groundwater flow ond transport modeling results within broader water resources or hazardous waste management studies where risk analysis requires and incorporates groundwater uncertainty.

The work over the last quadrennium can be grouped into three broad areas: (1) statistical analysis of parameters and inputs that influence groundwater, the main methodological approach being optimal linear estimation (kriging, state estimation), (2) stochastic prediction of model outputs, the main approaches including spectral analysis and Monte Carlo simulations, and (3) statistical analysis for groundwater model identification and parameter estimation. In all three areas, special sessions have been held at national and international symposia to disseminate results. While significant results have been obtained, much work remains in developing fundamental theory that relates the scale of the process to equation formulation in a manner that incorporates the heterogeneity of the medium. This work is critical to the groundwater transport problem.

During the last quadrennium, the awareness of groundwater contamination from hazardous wastes—especially chemical wastes—has grown. As data from waste sites are being collected and attempts to model contaminant transport are made, it is clear that current models and procedures are insufficient in at least two areas: (1) relationships among microscale heterogeneity, numerical model representation and data collection are not well coordinated at the landfill site scale, and (2) understanding of the chemical processes (for example, adsorption or desorption), biological processes (for example, degradation of chlorinated hydrocarbons), or physical processes (for example, relative conductivities or mixing properties of multiphase organics in saturated media) is incomplete.

Fundamental work, including both laboratory and field analyses, is required if progress is to be made at improving the predictive capabilities of groundwater transport models.

In surface water hydrology, progress has been made on several fronts. Most notable in the area of engineering hydrology are advances in the implementation of on-line flood forecasting systems. During the quadrennial period, fundamental advances were achieved in applying systems theory and state-estimation to on-line hydrological forecasting. These advances include model structure identification and parameter estimation, as well as embedding hydrological models within a state-space framework capable of the necessary feedback to incorporate on-line data. Some of the most important work has been in the area of parameter identifiability for conceptual hydrological models. Results indicate that the available data are insufficient to estimate all the parameters accurately—either the models need to be simplified or additional components of the hydrological budget need to be measured.

The implementation of on-line flood alert systems, coordinated by the U.S. Nadonal Weather Service, has grown by a factor of ten during the quadrennium, with the demand for such systems growing far faster than state and federal agencies can fulfill. The National Weather Service is leading the way in this important area. The most notable aspect is the desire of field hydrologists to incorporate recent research results into these systems. Internationally, this area is gaining in importance, as can be seen from recent conferences devoted to flood forecasting (e.g., IAHS, 1980).

The current quadrennium saw consolidation rather than significant developments in the area of statistical hydrology. The last quadrennium ended with a conference on hydrologic data networks. Langbein (1979), in summarizing the conference, recommended five areas where the research results could be extended and applied to important data acquisition problems. These recommendadons included: data transfer among stations (regionalization), broaden the scope so as to apply techniques common to surface water to other hydrological areas, carry out audits to see how networks fulfill current or modified objectives, investigate how data needs vary with water management objectives, and improve coordination among various data networks.

The general area of regionalizaton, as applied to flood frequency, has received more attention during the current quadrennium than other topics. The concern has been twofold: (1) development of statistical models and procedures that better represent flood data and (2) development of robust estimates using regional data in a hydrologically and statistically responsible manner. In the research community, there is wide belief that current operational methods should be improved.

Fundamental research into flow generation and basin structure has started to pull together work in widely varying areas: geomorphology, soil physics, surface hydrology, and statistical hydrology. A unifying theory for hydrologic responses at varying basin scales has not yet been developed; work during the last quadrennium focused upon various issues including 1) the basin response and flood statistics based upon its geomorphological structure, (2) soil variability and runoff variability, and (3) role of macropore flow, interflow, and contributing area surface runoff in the flow response. It is crucial that adequate and detailed data be available so that theories concerning runoff generation can be adequately tested.

In hydrology, the long-term trend appears to be a bifurcation of the field into scientific hydrology and engineering hydrology. Exciting developments in scientific hydrology will be made in all areas: equation formulation for porous media flow, advances in our understanding of hydrological processes at various scales, and improved statistical representation of hydrological processes in time and space. One hopes that equally exciting developments will occur in engineering hydrology. At present, one sees some very creative applications of research results—especially in the area of groundwater modeling. It is important for the engineering side of hydrology to understand recent developments and to apply them where appropriate; likewise it is important for those in hydrologic research to understand the problem faced by field and engineering hydrologists.

References

IAHS, Hydrological forecasting symposium, *IAHS-AISH Publ.*, *129*, 571, 1980.
Langbein, W. G., Overview of convergence on hydrologic data needs, *Water Res. Res.*, *15*, 1867–1871, 1979.

Contents: IUGG Quadrennial Report
Hydrology

Geodesy 1979–1982

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The growing interaction of geodesy with its kindred disciplines, oceanography and tectonophysics, may have been the most significant trend in geodetic activity during this past quadrennium. Geodetic observing systems are now capable of measuring so much more precisely (to the cendmeter level) and over such a broader extent (like the oceans), that their results add materially to knowledge of crustal and mande structure, of ocean bottom relief, and of oceanic circulation. Especially important is the application of precise, repetitive geodetic measurements to the detection and analysis of time-varying effects. Examples are the utilization of altimeter data to yield ocean boundary current changes, and of radio interferometry and laser ranging to systematically monitor polar motion, earth rotation, and crustal movements.

There has also been an increased awareness of the value of classical observations of leveling and gravity for analyzing crustal structure and movement. Particularly in leveling, a large effort has been made to expose systematic aberrations so that the intrinsic precision of the measurements can be properly exploited.

A perusal of the presentations at the semiannual meetings of the American Geophysical Union over the past 4 years indicates not only that a major portion of the geodetic sessions has been devoted to these topics, but that many papers in the oceanography and tectonophysics sessions employ geodetic theory and observations to an extent never evident before.

The traditional tools for making geodetic observations are in the process of giving way to more rapid, precise (and complicated) devices. Inertial surveying systems have already yielded operational results, and the Global Positioning System is on the verge of doing likewise. The report for the next quadrennium will undoubtedly feature the consequences of this incipient revolution in geodetic surveying methods.

In contrast to the period 1975–1978 during which Geos 3, Lageos, and Seasat were launched, no comparable satellites became operational within the period under review. This circumstance, however unwelcome, forced scientists to thoroughly scrutinize the data recently amassed. Visible examples of this emphasis on analysis were two special issues of the *Journal of Geophysical Research*, Vol. 84 (B8), June 30, 1979, on Geos 3; and Vol. 87 (C5), April 30, 1982, on Seasat.

During the past 4 years, the American geodetic community benefited from the guidance provided by several committees of the National Research Council, U.S. National Academy of Sciences, especially the Committee on Geodesy. The work of these committees is delineated in a series of reports which furnishes an excellent panorama of the geodetic interests prevalent today in the United States. These publications by the National Academy of Sciences, Washington, D.C., are: *Impact of Technology on Geophysics*, Geophysics Study Committee (1979); *Applications of a Dedicated Gravitational Satellite Mission*, Committee on Geodesy (1979); *Need for a Multipurpose Cadastre*, Committee on Geodesy (1980); *Geodetic Research and Development in the National Ocean Survey*, Committee on Geodesy (1980); *Federal Surveying and Mapping: An Organizational Review*, Committee on Geodesy (1980); *Geodetic Monitoring of Tectonic Deformation—Toward a Strategy*, Committee on Geodesy/Committee on Seismology (1981); *Modernization of the Public Land Survey System*, Committee on Integrated Land Data Mapping (1982).

Special symposia on geodetic topics held in the United States for the period 1979–1982 were: Second International Geodetic Symposium on Satellite Doppler Positioning, Austin, Tex. (January 22–26, 1979); Radio Interferometric Techniques for Geodesy, Westford, Mass. (June 19–21, 1979); Ninth International Symposium on Earth Tides, New York, N.Y. (August 17–26, 1981); Third International Geodetic Symposium on Satellite Doppler Positioning, Las Cruces, N.M. (February 8–12, 1982).

One reason for this comparatively small number compared to the two previous quadrennia is that other countries have been sponsoring more international meetings. U.S. scientists have participated actively in, and U.S. organizations have cosponsored, many symposia taking place elsewhere.

However, the chief indication of the continued vitality of geodesy in the United States is not displayed by conference activities but by the evidence of theoretical and practical results as manifested in the following reports on specific accomplishments, and the accompanying bibliographical records. These certainly are not complete. The proliferation of geodetic pursuits and applications has rendered more difficult than ever the task of encompassing within these reviews the entire field of endeavor. Following the precedent of the editors of the previous two quadrennial reports, I apologize for inadvertent omissions.

Contents: IUGG Quadrennial Report
Geodesy

Seismology 1979–1982

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The years 1979 to 1982 have been marked by a continuing expansion and development of seismology in the United States. In this Introduction, we summarize some of the highlights of this period as a prelude to the more detailed papers that follow. These papers cover improvements in our understanding of earth processes together with improvements in the various geophysical techniques available to study them.

Perhaps the most traditional area of seismology is the study of the structure of the earth's interior, though recent developments are following most untraditional directions. Highlights of this area include significant new information on lateral heterogeneity, anisotropy, and the mechanisms of scattering and attenuation. Using a variety of techniques, we are beginning to identify the regions of the earth that are the most heterogeneous and to characterize the heterogeneity in those regions. The upper mantle has long been known to contain lateral variations, particularly in the uppermost part. New data are beginning to suggest substantial heterogeneity in the transition region between 400 and 670 km depth. In addition, more evidence is confirming lateral variations in the lower 200 km of the mantle. Attempts to relate these various heterogeneities to tectonic processes at the earth's surface and motions in the earth's core are continuing.

Attempts to establish a reference earth model that is in some sense a best fit to a wide variety of seismological data are approaching completion. An interesting conclusion of this work was that the overall fit can be improved by the inclusion of elastic anisotropy in the upper 220 km of the earth's mantle. This anisotropy is transverse, with a vertical axis of symmetry. Regional studies have often indicated some degree of both transverse and azimuthal anisotropy. We are now beginning to assemble these observations into a consistent picture which will, hopefully, relate in some way to convection processes.

Scattering and attenuation have long been of interest for two reasons. First, we need to understand more about the physical mechanisms of attenuation at a wide range of frequencies. Second, the seismic aspects of test-ban treaty verification require that we be able to correct for attenuation in order to make accurate estimates of seismic yield. While we continue to refine the large-scale variations of the attenuation parameter Q using normal modes, some interesting new results are providing information in the short-period band. It seems likely that there may be a significant frequency dependence of Q in the 0.8 to 1.5 hz range, corresponding to a simple relaxation band in pure shear. Regional variations in attenuation, and complications due to scattering, are known to occur, but many details of these phenomena are not well understood.

Seismic studies of the earth's crust have continued to expand during the last four years and now represent perhaps the most active area of seismology. Many of the techniques that have been perfected in the exploration industry are now being applied to the study of the earth's crust (particularly the deep crust) and upper mande. At the same time, we are developing ways of generating synthetic seismograms for a wide variety of structures and are moving towards the application of inversion methods to determine structure.

U.S. activities in crustal seismology have been dominated by the continuing Consortium for Continental Reflection Profiling (COCORP) project, a portable 100 station array built by the U.S. Geological Survey (USGS), and an increased use of marine multichannel systems. COCORP continues to make detailed investigations of important structures in the United States and is contributing valuable new data to the regional geologist. Particularly interesting results were obtained in the Wind River Mountains of Wyoming, the Rio Grande Rift zone, and the Appalachian Mountains. The deployment of a large digital array in the Snake River Plain has clarified the transition from the Plain to the Basin and Range province. Other studies in California have provided valuable information on the Imperial Valley and the Mohave Desert regions. Marine studies using both reflection systems and ocean bottom seismometers have tended to focus on the continental margins. Here it has been possible in a number of areas to clarify the sedimentary col-

umn and its structural relationship to the continental basement.

The crustal seismology studies overlap with many other investigations in the general area of seismotectonics, the study of processes in active regions. In this area, improved techniques in hypocenter location, long period body wave modelling, and routine estimation of the seismic moment tensor have led to new insights into the faulting process. The characteristics of subducting slabs continue to be explored. Complexities in slab shape due to very shallow dipping subduction in some regions have been established. At deeper depths, more and more slabs are being demonstrated to contain clearly separated seismic zones, though the processes involved are still open to question. Interpretations of data collected during the Rivera Ocean Seismic Experiment (project ROSE) are now being published. These have provided detailed information on the relationship between seismicity and structure near a mid-ocean spreading ridge. Some events were clearly related to a topographic trough, while others were not obviously related to topography of the sea bottom. In another area, a number of investigations are beginning to unravel the complex tectonic processes at work in the Caribbean region.

In the field of earthquake prediction, progress in understanding short-term precursors has been slow. Efforts have been focused on improving our understanding of the nature of the earthquake process and its relationship to host rock and fault gouge properties. Modeling shows distinct promise, and we are beginning to understand the ways in which complexities in prestress distribution and rock properties influence fault propagation and stopping. More success is being identified in the area of long-term predictors. Estimates of recurrence rates are constantly being improved, and the seismic gap concept has been successfully applied to the actual prediction of two earthquakes. The continued high level of research activity in earthquake prediction suggests that we are slowing moving towards real success in this field.

Research in theoretical seismology has concentrated primarily on the synthesis of near, regional, and far field waveforms due to a variety of source models. In the near field, a number of techniques have been developed to take account of local structure. However, much remains to be done in including the complexity of the seismic source, which is the dominating factor at high frequencies. The construction of regional synthetics has been spurred by the test ban treaty verification program and is making substantial progress. Modifications to the classic Thomson-Haskell technique allow the calculation of P-SV and SH synthetics in a variety of structures. In the far field, the emphasis has been mainly on the inversion of network waveforms to derive the seismic moment tensor. Other theoretical studies have continued work on the dynamics of fault rupture, and wave propagation from explosive sources.

The field of strong motion seismology has grown rapidly during the last four years. The measurement, interpretation, and prediction of near field ground motion due to earthquakes has been impacted by a substantial growth in the number of instruments deployed, in the amount of data available, and in the interest of agencies concerned with hazards reduction and potential damage to critical structures. Over 2700 strong motion accelerographs have now been deployed in the United States. While most of these are analog instruments, from which the data need digitizing for processing, there are an increasing number of digital instruments. The 1979 Imperial Valley earthquake generated a particularly extensive data set that has been the basis for many investigations. Near field waveforms are affected by source characteristics, propagation path, and site response. While all are important, our ability to predict strong ground motion is apparently most limited by our understanding of the seismic source.

The increasing use of digital instrumentation has not been limited to the strong motion area but is taking place throughout seismology. Most importantly, we are establishing a global network of digital seismic stations, consisting of the Seismic Research Observatories (SROs) funded by DARPA and managed by the USGS, and the stations of the WWSSN network that have been upgraded to digital capability by the USGS. The dynamic range of these instruments has already proven their immense superiority over the older analog seismograms. At the same time, the amount of data generated is large, and we are still in the process of establishing the management techniques that will make the data easily available to the seismological community. In spite of this, the new digital data have made very significant contributions in practically all areas of seismology, and we expect this to increase in the future.

While it is impossible to cover every single area of seismology, the review papers that follow show clearly that seismology is an active, exciting field that is having an important impact on many fields of geology and geophysics.

Contents: IUGG Quadrennial Report
Seismology

News

EGT Project

The European Geotraverse (EGT) has been planned as a major geoscience project that will run for 5–7 years involving collaborative efforts of geophysicists, geologists, petrologists, geodesists, and other geoscientists from different European countries. A first draft proposal was elaborated in 1981 by a Working Group of the European Science Research Councils (ESRC), a standing committee of the European Science Foundation (ESF); it was subsequently modified following the amendments requested by the ESRC and was finally approved by the General Assembly of the ESF on November 9, 1982.

The broad aim of the EGT is to secure an understanding of how the continental lithosphere formed and reacted to changing physical and geometric conditions through time. One of the best locations for such a study is Europe because it is made up of a number of tectonic provinces ranging in succession from the oldest Precambrian areas of Scandinavia to the currently active area of the Mediterranean. The concept of a geotraverse has been chosen in order to provide a continuous, integrated study of sufficient scale to cross this whole region like a swathe that will give new information about the dynamics and vertical and lateral variations of the lithosphere, both within and between adjacent provinces.

Geophysical and geological surveys carried out so far have revealed important features relevant to the objectives of the EGT. At the same time, however, they have disclosed a number of fundamental problems that can only be tackled within the framework of a wide-scope, multidisciplinary, large-scale project.

Extending from the northern tip of Scandinavia southward to North Africa the ECT is located to encompass the pre-2500 Ma old Archaean nucleus in the northernmost part of the Baltic shield; the Proterozoic, Paleozoic, and Cenozoic provinces of northern and central Europe that have been added on to this nucleus; and the active transition zone between the Eurasian and African plates in the Mediterranean area.

The ECT has been chosen such that—proceeding from north to south—a 4000-km-long section is obtained which, in three segments, covers the whole time span of the history of the continental lithosphere. From a tectonic-geologic point of view, Europe can be divided into three main units: (1) the Precambrian shield of Fennoscandia (age ~3100 to ~600 Ma) with its border regions, including the Caledonides (age ~600 to ~400 Ma); (2) the Hercynian (Variscan) realm of central and western Europe (age ~400 to 230 Ma); and (3) the Alpine-Mediterranean region (age 230 Ma to present).

A thorough understanding of the tectonic processes requires detailed knowledge of the structure and dynamics of the whole lithosphere, including not only the crust but also the underlying mantle, which is intimately bound up with it.

A large-scale geotraverse is required both to provide lateral continuity of information across the major structural elements of Europe and to achieve a deeper view of variations within the lithosphere. It is intended that the results of the investigations will be integrated to produce a north-south section through the crust and upper mantle of Europe which will provide the basis for a reconstruction of the evolutionary development of the various provinces of Europe and their mutual interaction. This should provide a better insight into the structure and dynamics of the lithosphere-asthenosphere system, which in turn will be of general scientific benefit. Although certain techniques are proposed for the full length of the ECT to provide continuity and depth of information, most of them will be applied selectively so that the combination of methods utilized will be those most appropriate to the particular problem under investigation. Vital to the concept of the ECT is that it should be carefully directed and contain within its broad-scale framework a number of linked experiments with specific geological objectives to derive the detail that is essential.

The goals of all these various experiments can only be accomplished by close international cooperation. Since the aims of the ECT require a continuity of information on a large scale, it is mandatory for these investigations to be carried out in the form of a "Joint Program."

Two specific projects where the scientific objectives are essential to the aims of the ECT, but which cannot be realized along the EGT as such, have also been included in the ECT Joint Program. They are of fundamental importance to the understanding of the crust and mantle in Hercynian Europe.

EGT Joint Program

1. Simultaneous geomagnetic observations along the ECT.
2. Mapping of the resistosphere and conductosphere along the EGT.
3. Mapping of the lithosphere-asthenosphere system by seismological techniques along the EGT (seismic surface waves, crustal transfer functions, and *P* delay studies).
4. Deep seismic sounding of the lithosphere (southern segment of the EGT).
5. Multidisciplinary (tectonic stratigraphic sedimentological, petrological, geochronological, paleomagnetic, and anisotropy) studies as well as synoptic geophysical surveys in the Southern Alps, Po Valley, and Northern Apennines.
6. Deep seismic sounding of the lithosphere (central segment of the EGT).
7. Synoptic geological and geophysical studies of border regions between different tectonic units of Hercynian age (central segment).
8. Multidisciplinary study of the contact zone (Tornquist-Teisseyre Line) between Precambrian and Hercynian Europe (southern Norway–southwestern Sweden, Denmark–northern Germany).
9. South Scandinavian east-west traverse: a multidisciplinary study across Sveconorwegian crustal units, the Oslo rift, the Protogine zone, the Smaland-Varmland granite belt, and into the Svecofennian province.
10. Multidisciplinary studies of the evolution of the Baltic Shield (seismic, magnetotelluric, paleomagnetic, radiometric, and tectonic studies along the FENNOLORA Traverse and adjacent areas).
11. Large-scale anisotropy study of the upper mantle in the Hercynian domain of Iberia.
12. NARS; A wide-aperture seismological array surveying the upper mantle along the traverse Göteborg-Malaga (down to a depth of about 600 km).

Some of the experiments listed above making up the EGT Joint Program are already in an advanced stage of planning (such as experiments 4 and 9) and are scheduled to be carried out in 1983 and 1984, respectively. One of the studies (experiment 12) is already in progress. Steps toward the planning of the other projects have been undertaken by various geological and geophysical institutions in a number of European countries.

Those experiments contributing to the basic objectives of the EGT on a regional and more detailed scale that can be realized as part of national or multinational programs are included as "Regional Studies." They are quite numerous and, therefore, for the sake of brevity are not listed here.

Organization and Coordination

A multidisciplinary international program of the size and duration outlined above will need an organization and coordination that secures the steady progress and realization of the EGT objectives. An EGT Scientific Coordinating Committee was formed to supervise the compilation and the inventory of the data and results relevant to the EGT. It will also identify and encourage those research proposals that meet the objectives of the EGT.

Three sectional groups, one for each of the northern, central, and southern segments of the EGT, will plan in detail and supervise the execution of the Joint Program and advise on those regional studies to which priority shall be given.

The ESF Secretariat in Strasbourg will assist the Scientific Coordinating Committee in administrative matters and ensure the organization of sectional and regional working group meetings. It will also help in synchronizing the various activities, channel information, and organize an annual workshop of scientists who actively participate in the EGT.

Since the realization of the Joint Program, running for a period of 5–7 years, requires funding beyond the scope of an "Additional Activity" of the European Science Foundation (ESF), it was proposed that contributions to this program would have to be secured on national level by the appropriate funding agencies. The ESF in agreement with its primary role will coordinate the implementation of the national efforts.

A separate budget for the costs of "Coordination" has been established within the framework of an Additional Activity of the ESF, which is financed by contributions from the participating member organizations already agreed upon at the last ESF General Assembly in November 1982.

The Regional Studies will have to be funded by the appropriate national agencies according to the specific scientific interests and needs of the different countries and the available financial means.

The members of the EGT Scientific Coordinating Committee are St. Mueller (Zürich, chairman); A. Berthelsen (Kobenhavn); P. Giese (Berlin); C. Morelli (Trieste); D. Blundell (London); H. Zwart (Utrecht); A. Hirn (Paris); E. Banda, Scientific Secretary (Institute of Geophysics, ETH-Hönggerberg, CH-8093 Zürich, Switzerland).

Further information can be obtained through the Scientific Secretary or through H. Munsch, Secretary of the EGT at the European Science Foundation, 1, Quai Lezay Marnésia, F-67000 Strasbourg, France.

This news item was contributed by Stephen Mueller, Institut für Geophysik, ETH-Hönggerberg, CH-8093 Zürich.

ERL Director Resigns in Protest

George H. Ludwig resigned in protest last month from his post as director of the National Oceanic and Atmospheric Administration (NOAA) Environmental Research Laboratories (ERL). Ludwig, who will retire in February 1984 after 30 years of government service, told *Eos* that he resigned "with the intent of making a statement" about changes within NOAA that he says are weakening the agency's research program. Ludwig is now the assistant to the National Aeronautics and Space Administration's (NASA) chief scientist.

"The NOAA reorganization process of the past year has been unusually traumatic for ERL," Ludwig explained in a memo to his ERL colleagues when he announced his departure. "Specific actions have shifted many of ERL's long-standing management responsibilities elsewhere in the [Department of Commerce] and NOAA."

He cited "the movement of most of our research support services (including management of the Cyber 750 research computer and library)" to the NOAA/Commerce Department administrative support centers, "our loss of most of the funds appropriated to solve our computing needs over the next decade, and the impending transfer of our research aircraft to the NESDIS [National Environmental Satellite Data and Information Service]." He told *Eos* that he feels the movement of these support services away from ERL means that these services will be less responsive to NOAA's research needs because the management control would be farther away from the research organization.

"This process has recently progressed to the point where decisions have been made before I was even given an opportunity to discuss them. This state of affairs clearly reflects a difference of opinion about the level of resource control and programmatic authority required by the ERL director," Ludwig told his colleagues. "Although I have never argued for complete autonomy without responsible planning and accountability, I have consistently held the position that many elements of administrative decision making and the control of the tools of research should be at a level where the details of the research programs and of the process of research are clearly understood. In many instances this will no longer be the case, and I expect that the research program will suffer."

Neither NOAA Administrator John Byrne nor NOAA Deputy Administrator Anthony J. Calio has given an official reaction to Ludwig's resignation. However, Byrne told *Eos* that he is "disappointed that he [Ludwig] resigned" and attributed the resignation to a sense of fatigue and frustration with the increasing bureaucracy placed on government employees, particularly with an administration that has altered the structure of government. Byrne also said that in the past few years NOAA has become closer to, and is doing more work in concert with, its parent Commerce Department. This could cut into the flexibility of middle level managers, Byrne said; he suspects this may have played a role in Ludwig's resignation.

Ludwig, a codiscoverer of the Van Allen radiation belts, joined ERL in 1960 as a senior scientist, coming from a management position in the satellite service. It was a conscious move, he said, to go back to research. In August 1981, he succeeded Wilmot Hess, now director of the National Center for Atmospheric Research, as ERL director.

When Ludwig became ERL director, he and NOAA Administrator Byrne discussed whether an ERL director was needed and whether the ERL director should be based in Boulder, Colo. "I felt we had an excellent basis of agreement," Ludwig said. One year later the entire issue arose again. The NOAA reorganization that was suggested in early 1982 included plans to coalesce five of the nine current ERL laboratories by combining them into a single regional laboratory. In this concept, the five current environmental research laboratories would have been downgraded in "program elements." Last August, though, NOAA Administrator John Byrne decided not to reorganize ERL. Since then, Ludwig says, a series of small but substantive changes have altered significantly the management of research support services for ERL's program.

"Many of the changes which have actually occurred are, I believe, serving to weaken, rather than strengthen, NOAA's research activities," Ludwig told the ERL laboratory directors and staff when he announced his resignation. Nevertheless, he told *Eos*, he still believes strongly in NOAA. He said he hopes his resignation will serve as a constructive step and that it will focus increased attention on the strengths of the NOAA research program.

In the late 1950s while at the University of Iowa, Ludwig worked with James Van Allen and shared in the discovery and early delineation of the Van Allen radiation belts. After earning his Ph.D. at Iowa in 1960, he worked at the Goddard Space Flight Center in various capacities for a dozen years and then went to several management positions at the satellite service. Ludwig received the NOAA Program Administration and Management Award in 1977, the NASA Exceptional Service Medal in 1969, and the Academy of Achievement Golden Plate Award in 1962. Also that year he was pictured in *Life* magazine as one of 100 outstanding young men. He is a member of the Committee on Data Management and Computation of the National Academy of Sciences.

At NASA, Ludwig will work on space research data management. As part of the project, he will examine existing policies and general practices for the acquisition of data on space and will look closely at how such data are distributed, processed, and archived for research. The project aims to lay a foundation for future data management and policy formulation.

A search for a new ERL director is in the initial stages.—*BTR*

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Transactions, American Geophysical Union

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Subscription price to members is included in annual dues ($20.00 per year). Information on institutional subscriptions is available on request. Second-class postage paid at Washington, D. C., and at additional mailing offices. *Eos, Transactions, American Geophysical Union* (ISSN 0096-3941) is published weekly by

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D. C. 20009

Cover. The continental crust of Europe is divided into four tectonic realms, from oldest to youngest: Precambrian Europe, Caledonian Europe, Hercynian Europe, and Alpine Europe. Within each realm a further subdivision is shown, according either to the age or style of deformation, to the age and nature of the rocks involved, or to the intensity of accompanying metamorphism and/or magmatism. Precambrian Europe (~3100–600 Ma) comprises (1) the Baltic Shield, with exposed Precambrian crust, and the East European Platform where Precambrian crystalline rocks occur beneath younger sediments (except in the Ukrainian Massif where the basement has been uplifted and exposed) and (2) the buried Precambrian basement of the Midland Craton–Brabant Massif (stretching across the English Channel). Tectonically, the Precambrian crustal rocks of northwest Scotland and the Outer Hebrides belong to the North American–Greenland Shield. Caledonian Europe (~600–400 Ma) encompasses the British–Scandinavian Caledonides and the north German–Polish Caledonides. The supposed collision suture in the British Caledonides is shown with a dotted line. Most of the north German–Polish Caledonides is deeply buried beneath younger sediments. Hercynian Europe (~400–230 Ma) once formed a wide mountain belt (the Hercynides or Variscan mountains), but is now composed of a number of massifs of varying size, and intervening areas with Hercynian basement. The supposed Hercynian collision suture is shown as a dotted line. Alpine Europe (~230 Ma to present) comprises the young mountainous regions north and south of the Mediterranean, formed in relation to the collision between the indented Eurasian and African plates. In pre-Alpine Europe, incipient rifting initiated the formation of the Rhône-Bresse-Rhine graben system around 50 Ma ago. The Mediterranean region is presently subjected to strong tectonic activity. (See news item p. 458.)

Z^0: The Extra Force

Researchers at CERN (European Center for Nuclear Research) have reason to believe that they have finally observed the elusive superheavy Z^0 nuclear particle. The observation is important because it represents the unifying link between the physics of weak-field phenomena and electromagnetic forces. The Z^0 particle was predicted by the Salam-Weinberg model, which is an attempt to pull together all physical forces into a single field theory. The as yet uncalibrated experiments at CERN project the new particle's mass at 95 ± 5 CeV, or about the equivalent to the combined masses of 95 protons. What remains in the search for such nuclear particles are "heavier Z^{0}" particles (200 CeV), "top quarks," and "Higgs particles," all of which are parts of the Salam-Weinberg model.

The Z^0 particle is related to, and in some way analogous to, the photon (though much more massive). Photons and Z^0 particles are both involved in electromagnetic forces, but Z^0 carries an extra force, which is the weak field contribution that results in a violation of parity. The Z^0 is considered the link between weak interactions and electromagnetic fields because it benignly mediates both.

The discovery of the Z^0 particle may mark the end of the experimental road for the pioneering aspects of particle physics. In a report about a recent discussion of the finding of the particle, R. Walgate says that further steps to test the grand unified theories will require comparatively high energies, on the order of 10^{15} GeV or higher. These energies are not feasible in any existing or planned facility (*Nature*, June 9, 1983).

The path of experimental research leading to discovery of the Z^0 was exciting, elegant, and perhaps was sufficient evidence of weak field existence in itself. F. Close described experiments to test for the "tell-tale signature" of the presence of the extra (weak) force. The parity violation, or departure from mirror plane symmetry, if detected, is a measure of weak force interaction. In parity-conserving interactions, the weak field effects are manifested in other ways. Indeed, experiments with left- and right-handed (polarized), high-energy electrons have demonstrated small violations of mirror-symmetry. Likewise, experimental electron-positron (collision-annihilation) processes have been controlled to detect weak fields by analyzing the resulting antimatter equivalents.

As was described by Close (*Nature*, May 26, 1983) "If the electron-position annihilation were controlled only by the electromagnetic interaction, then processes that produce μ^- and μ^+ (muons and antimuons) would yield the μ^+ in the forward hemisphere marginally more often than in the backward. (Momentum is balanced by the μ^- emerging in the other hemisphere.) If the weak interaction also plays a part, as in the Salam-Weinberg model, the μ^+ should emerge more often in the backward hemisphere." Close goes on to describe that this is exactly what has been observed.

The new CERN experiments involved proton-antiproton collisions in a device that is fed by the Super Proton Synchrotron (SPS). As the high-brilliance, high-energy beams collided, numerous particles were released, including weak-field charged particles (w^+ and w^-) and the neutral Z^0 particles. The decay of these particles produced tracks in the facility's gas-filled image chamber. As a Z^0 decays, an electron-position pair is emitted, the two producing diagnostic straight-line tracks in opposite directions.

New directions in the study of electro-weak field theory, and its unity with electromagnetic field theory, will first involve improvements in the beam quality of the particle colliders. Higher energy experiments probably will not be obtainable in this decade. According to R. Walgate (*Nature*, June 9, 1983), "Another possibility is to search for Centauro events, seen a few times in cosmic rays, which indicate that a new kind of physics may set in at energies not much above present values."—*PMB*

New Pulsar Discovered

The discovery of a fast-spinning pulsar that is part of a binary system may provide a key to resolving the controversy over the nature of pulsars. Valentin Boriakoff of Cornell University, working with two Italian astronomers, Rosalino Buccheri and Franco Fazio, discovered the pulsar and its companion by using the 305 m radio telescope of the National Astronomy and Ionosphere Center near Arecibo, Puerto Rico. The astronomers concluded that the newly discovered pulsar is part of a binary system because its pulsing period is not constant, a sure sign that something else is in the vicinity.

Spinning at 163 times per second, the pulsar is rotating slower than the pulsar discovered at Arecibo last November (642 times per second), but the binary nature of the new discovery may help answer the question whether

News (cont. on p. 460)

News *(cont. from p. 459)*

a pulsar's rate of spin is accelerated by the transfer of mass from a companion or whether a pulsar comes into existence already spinning. Most astronomers consider pulsars to be remnants of supernovas or exploding stars that collapsed into extremely small, dense objects and emit intense short bursts of radiation at regular intervals.

Designated P1953+29 for its coordinates in the sky between the constellations Vulpecula and Cygnus, the pulsar orbits its companion every 120 days. The pulsar is 11,500 light years from earth and has a diameter of about 9.5 km. Its mass has not been determined. Two unique features of P1953+29 are the emission of radiation for at least 42% of its rotational period (an unusually high rate for a pulsar with this particular spin rate) and its drastic changes in pulse shape at different receiver frequencies.

P1953+29 was discovered when the astronomers were searching the sky for fast-spinning radio pulsars in an area where a satellite had previously discovered some point sources for gamma rays. Because P1953+29 is located close to one of these point sources, the astronomers will try to find a physical association between the pulsar and the source by conducting simultaneous observations by using the Arecibo telescope together with other experiments. One of the first such projects is a simultaneous observation with the balloon experiment FIGARO, a French-Italian joint venture scheduled for release in Brazil in late 1983.

Synchrotron Advances

Mineral physics studies, which gain precision as time decreases during a measurement, will benefit greatly from the availability of beams existing from synchrotron facilities. Unusually intense radiation is emitted from a synchrotron in the broad spectral range from the infrared through the X ray region and beyond. For example, X rays, which are released from such a facility at intensities of 10^9 times those of conventional generators, can be used for studies of mineral structures, such as XFAS (X ray fine structure) and photoionization, which were unthought of only a decade ago.

One reason for this new capability is that accessories for synchrotrons called wigglers and undulators have evolved from the laboratory-curiosity stage to useful devices during the same period. These new devices step up the brilliance (flux per steradian for a unit source area of a narrow wavelength band) of a synchrotron-produced beam and can be adjusted so as to extend the spectral range of the radiation. The truth is that most of the old and even the new synchrotrons were designed or planned without the knowledge that wigglers and undulators would be successful, according to a recent report (*Physics Today*, June 1983).

Now a number of totally new synchrotron facilities are being proposed that will contain a large number of wiggler and undulator magnets, and, essentially, will not even make use of the normal radiation yielded by the synchrotron bending magnets. Wigglers and undulators are, of course, being adapted to existing facilities and to those under construction currently. All of this recent upgrading of synchrotron radiation beams will benefit state-of-the-art mineral physics studies.

What is synchrotron radiation, and what are wigglers and undulators? Electrons and positrons are the charged particles that are accelerated around a circular path in a synchrotron. The curved motion is the steady-state acceleration (change in direction) and this causes the particles to lose energy. Synchrotrons were originally designed to study or otherwise employ the high-energy, charged particle beam, not the white radiation that is emitted as the energy loss due to the curved motion in a magnetic field. This white radiation had been thought to be of potential future use in physical measurements. It is this radiation that is being exploited for mineral physics and other condensed matter studies.

The standard bending magnets in a synchrotron yield intense, broad, fan-shaped beams of radiation (for electrons of 1 GeV the cone angle of emitted radiation is about 1 mrad). For X ray diffraction studies of minerals, however, the wavelengths are not sufficiently short and simultaneously intense after passing through collimators and monochrometers to be of significant improvement over conventional X ray generators.

Wigglers and undulators are periodic magnets that can be inserted in the sections of an electron storage ring that are free of other magnetic fields. These devices cause electrons passing through their fields to curve around and accelerate over relatively short distances and thus radiate the energy they lose in the process. The resulting radiation is a very narrow beam of greatly enhanced brilliance and extended wavelength.

The five synchrotron facilities in the United States are SURF (at the National Bureau of Standards in Maryland), CHESS (at Cornell University), SPEAR (at Stanford University), Tantalus and Aladdin (at the University of Wisconsin), and NSLS I and II (at Brookhaven National Laboratory). They are already in service in mineral physics studies, a few examples of which are instantaneous, single-crystal X ray structure determinations; high-pressure, diamond cell in situ, X ray diffraction measurements; bonding studies by energy-dispersive XFAS; and electronic structure measurements by photo-emission, in which the white synchrotron radiation can be tuned to observe the electron levels.—*PMB*

AIPG Membership

Members of ACU now are qualified to apply for membership in the American Institute of Professional Geologists (AIPG). The constitution and bylaws of the geologists' association require that applicants for membership hold prior membership in one of the societies affiliated with the American Geological Institute or in other scientific societies specifically approved by AIPG; AGU has been approved by the executive committee.

For additional information, contact AIPG national headquarters at 7828 Vance Drive, Suite 103, Arvada, CO 80003 (telephone: 303-431-0831).

Is Space for Ordinary People?

A blue ribbon Advisory Council to the National Aeronautics and Space Administration (NASA) recently reported the results of its 1-year study on whether to send private citizens on space shuttle missions. The answer from this panel, which was made up of an astronaut, a physician, several major space industry executives, and the author James A. Michener, was yes. If this result is acted upon, private citizens may fly on a shuttle mission in this decade.

The NASA Advisory Council claimed at the outset that the concept is not to be misconstrued as a self-serving public relations program. The main objective, it would appear, is for laymen to provide real functions in space missions; they could add a valuable dimension to the missions, if only by communicating first-hand space experiences to the general public. But, in addition to the widespread public interest in space, ordinary citizens are needed now and in the future: In-space technological manufacturing plants appear to be a good bet in a decade or so, and civilians can contribute to readiness programs as they work with highly specialized astronaut pilots.

Results of feasibility analysis of the private citizen in space are summarized as follows:

(1) Individuals can be flown by NASA without undue risk to either crew safety or accomplishment of the specific mission.

(2) Seats will be available, but there will be competing demands for them. Planning for a minimum program at this time is the best way to ensure seats for this opportunity.

(3) The flight experience is not particularly stressful if the person is trained in what to expect. If trained, one could adapt easily to the habitability requirements and the mission activities.

(4) The medical requirements will not be as rigorous as those for astronauts. They will focus on preventing medical/psychological situations developing in space that are hazardous to any or all who are involved.

A large part of NASA's objectives with the space shuttle program consists of addressing commercial and national security needs by gaining worthy experience in space. According to the Report of the NASA Advisory Council:

"The Space Act authorizes NASA to provide the widest practicable and appropriate dissemination of information concerning NASA's activities and the results thereof [203(a)(3)] and to foster 'the preservation of the role of the United States as a leader in aeronautical and space sciences and technology' [102(c)(5)]. NASA has been conducting effective information and education programs under this charter for some time. Persons who would produce more comprehensive mission documentation and educational material would significantly implement NASA's charter and augment its current activities."

Private citizens they may be, but the choice of the first several individuals will be the result of rigorous procedures, not only because of physical and medical considerations, but because their important contributions to the tasks of the space shuttle are in rather critical need. NASA needs capable help in space right now by people of various disciplines, people who can go on a space shuttle flight with as little as 100 hours of training in a 2-month period, not 5 or more years as is the case with shuttle astronauts.

Eventually, the program will be expanded. The current plans are to have an observer-in-space program of narrow scope but of great potential benefit to space science and industry.—*PMB*

TV Series on Geophysics

A seven-part public television series on earth sciences, dubbed "Terra Nova," is expected to begin filming this fall. The series, slated for prime time, is also designed as an introductory course in geophysics for college students who are not science majors. Completion of filming is expected in 1985; no air date has been scheduled.

Public television station WQED, Pittsburgh, in association with the National Academy of Sciences (NAS), is producing "Terra Nova." WQED and NAS collaborated on the production of the *Planet Earth* series, which originally aired some 25 years ago. The Annenberg/Corporation for Public Broadcasting (CPB) Project has provided a $3 million grant for "Terra Nova." Two years ago AGU gave $10,000 for NAS to develop basic scientific plans for the geophysics series.

Among the topics to be explored in the series are solar system cosmology, comparative planetology, solid earth geophysics, plate tectonics, mineral resources, hydrology, oceanography, climatology, meteorology, the sun, solar-terrestrial interactions, energy resources, human impact on the earth's environment, and the geologic environment.

To assist WQED in the production of the series, NAS established a blue-ribbon Geophysics Film Committee. Hugh Odishaw, dean of the College of Earth Sciences at the University of Arizona, is the committee's chairman. Other committee members are G. Arthur Barber, Charles L. Drake (AGU President-elect), Herbert Friedman, Laurence M. Gould, Thomas F. Malone, Roger Revelle, Alan H. Shapley, Eugene M. Shoemaker, Walter S. Sullivan, Verner E. Suomi, James A. Van Allen (AGU President), Pembroke J. Hart (committee secretary), John P. Schaefer, and J. Tuzo Wilson (former AGU President). NAS will provide scientific guidance throughout the series' production to ensure the scientific integrity of the films, according to Pembroke Hart.

For college instructional purposes, "Terra Nova" will include an innovative approach to the development of study guide materials, the series' planners say. Computer text processing and laser printing will provide college professors the opportunity to virtually create their own guide materials for the series, which will be divisible into 14 half-hour segments for classroom use or for rebroadcast on a syndicated basis by public television stations after the original prime-time airing in hour-long segments.

"Geophysics has progressed enormously in the past 25 years since *Planet Earth* was produced," said Thomas Skinner, executive president of WQED and project director for the new series. "There was no deep ocean exploration then, no space program. This will be the first time anybody has put together this information on geophysics into such a form. It is a marvelous subject matter today with and a chance to produce a landmark."

The Annenberg/CPB Project, funded in 1981 by a $150-million grant from the Annenberg School of Communications, is administered by CPB. Others who have committed to the financial support of "Terra Nova" are the American Meteorological Society, the Society of Exploration Geophysicists, the Arthur Day Fund, and the Atlantic Richfield Foundation.—*BTR*

New AGU Style Guide

A new, 18-page manual for contributors to AGU publications, called *AGU Style Guide for Contributors*, is now available. The guide covers text style and the mechanics of preparing manuscripts for any AGU publication in any format.

To obtain a copy, contact a journal editor or the AGU Publications office, 2000 Florida Avenue, N.W., Washington, D.C. 20009; telephone toll free 800-424-2488 or (D.C. area) 462-6903; or TWX 710-822-9301. Supplies are limited.

Books

Climate History and the Modern World

H. H. Lamb, Methuen, New York, xis + 387 pp., 1982, $33 (hardbound), $16.95 (paper).

Reviewed by William E. Riebsame

H. H. Lamb's latest book on the earth's changing climate is a carefully crafted work covering four areas: the physical basis of climate and climate change, the methods of climate reconstruction, the history of climate since the height of the last glaciation, and the impact of climate on human affairs. The book will be of particular interest to three groups. Atmospheric scientists interested in the long history of climate behavior (but perhaps overwhelmed by Lamb's all-encompassing work on the topic, *Climate: Past, Present and Future*, vol. II, Methuen, New York), will find *Climate History and the Modern World* to be a good titration of the fuller work. Scientists in other fields, including social scientists grappling with issues of climate-society interaction, will find the book a good entree into the field. Finally, Lamb himself suggests that the book will be useful to resource managers and other decision makers trying to avoid negative climate impacts. With this last audience in mind, no doubt, Lamb has chosen a style that eschews extensive footnoting and references (though sufficient citations are included to lead to further information). This works quite well and seems reasonable in view of his carefully documented previous writings.

Lamb's discussion of basic climatology maintains the connections between individual weather (e.g., extratropical cyclones) and climate elements and the broader issue of climate change. This integration fails, however, in sections on tornadoes and convection. His discussion on causes of climate is excellent (although parts of it are curiously repeated later in the book) for its demonstration of how climate at a point might change owing to instabilities inherent in the climate system without recourse to solar input, volcanic activity, and chemical changes in the atmosphere. When he does discuss these external forces, Lamb clearly delineates their climate role, uncertainty, and potential impacts. Lamb's review of reconstruction techniques is an excellent, parsimonious discussion emphasizing historical sources. It includes a valuable table outlining techniques and their application. Lamb's summary of climate history, comprising slightly over a third of the book, is a compendium of sources, regions, and events that only he could produce. This section can stand alone as a guide for the climate historian, though it may provide too much detail for more casual readers who will probably find more interest in the sections on climate impacts.

The climate history ends with 1950, and the subsequent record is incorporated into a discussion of the historical and contemporary socioeconomic role of climate fluctuation. This section is a mix of fact and opinion (facts like harvest failures and opinions on their historical moment). Lamb, like all climate historians, operates in a field of pitfalls related to the sufficiency of proof to implicate climate in past events. Some of his colleagues in the Climate Research Unit at the University of East Anglia, U.K., have recently written on how difficult it is to prove causality in past climate impact studies (M. J. Ingram, G. Farmer, and T. M. L. Wigley, Past climates and their impact on man, A review, in *Climate and History*, edited by T. M. L. Wigley et al., Gambridge University Press, New York). Nevertheless, Lamb's suggested impacts are reasonable, and his insight is a valuable guide to where we might look to refute or support the historical importance of climate change.

Having demonstrated the variability of climate and argued for its important role in human endeavor, Lamb ends the book with suggestions on how we might better cope with climate vagaries. He argues for climate forecasts based on empirical probabilities; indeed, Lamb clearly feels that forecasts based on theoretical atmospheric models may be misleading and bemoans the "disproportionate" research efforts put into computer modeling rather than into a fuller reconstruction of past climate behavior. Unfortunately, his discussion of climate forecasting is not as well organized as the rest of the book, and readers will be confused by the different time scales and approaches touched upon. Additionally, he pays little attention to whether even a correct forecast will be believed and acted upon. If climate forecasts are to help us with the "climate problem," we must know more about their applicability to resource decisions.

Lamb begins and ends the book by claiming that global society is becoming increasingly vulnerable to disruption by climate, a view he supports with Malthusian reasoning. Whether a climate anomaly eventually pushes some segment of global population into a Malthusian disaster or whether we simply continue to experience the hardships reasonably attributable to climate in conjunction with political and social causes, there is no doubt that we must strive to understand climate better. But we should not fall into the trap of doing nothing until we know everything. Lamb's book suggests that we already know a great deal about climate, and it makes this body of knowledge more accessible to a wide range of workers. No doubt, many more lives and much property could be saved by further drawing from this knowledge and our increasing understanding of climate-society interaction.

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Numerical Dating in Stratigraphy, 1 and 2

G. S. Odin (Ed.), Wiley-Interscience, New York, 1982, $134

Reviewed by Marvin A. Lanphere

Geology is a historical science, and geologists always have been fascinated with deciphering complex geologic histories by unraveling the relations of rock units where ages were established by fossils or, more recently, by isotopic dating methods. The most direct way to date stratified rocks is by measuring the ages of authigenic minerals in sedimentary rocks. This approach, however, is fraught with such problems as the presence of detrital minerals, the determination of whether authigenic minerals formed at the same time as accumulation of the sedimentary rocks, and whether suitable minerals for age measurements are present. This new book shows that although there has been significant progress, the problems of directly dating sedimentary rocks by isotopic methods persist.

The book is in two volumes. The larger part of the first volume is devoted to methodology. Subjects that are covered include methods of correlation; isotopic-dating methods; and utilization of minerals from sedimentary, volcanic, and plutonic rocks for physical age measurements. The rest of the first volume consists of papers dealing with calibration of the geologic time scale. The second volume contains 251 abstracts based on stratigraphic and isotopic data for critical points on the time scale.

Of the 34 papers in the first volume, 19 are contributions to Project 133 of the International Geological Correlation Program (IGCP) titled "Geochronology of Sediments." Most of the participants in this IGCP project were from European countries, and a primary objective was to establish a radiometric geochronology for the Mesozoic and Tertiary stratotypes in various parts of Europe. Unfortunately, interbedded volcanic rocks are rare, and the principal materials available for physical dating are glauconies, a general term used herein for authigenic green pellets in some sedimentary rocks. (Glauconite, a potassium-rich mica, is a relatively rare, highly-evolved glauconv.) The term "glaucony" has not yet made its way into geological dictionaries. Many of the studies deal with dating glauconies by using the potassium-argon method. Great progress has been made in understanding the mineralogy and evolution of glauconies, but the fact remains that they are less reliable for isotopic dating than are certain minerals in igneous rocks.

I found the part of the first volume on calibration of the geologic time scale to be uneven and disappointing. There were papers on the lower Paleozoic, upper Paleozoic, and Carboniferous; four on the Triassic; and one each on the Jurassic and Cretaceous, the lower Cretaceous-upper Cretaceous boundary, the Paleogene, and glaucony ages of the southeastern United States.

The second volume is by far the most valuable part of the book. The editor is to be commended for his success in persuading a diverse group of people to compile stratigraphic and analytical data and to present a critical discussion of many of the important time-scale points within a uniform and concise format. This second volume will be a major reference source for many years to come. Most of the abstracts deal with glauconies. Several time-scale points included in earlier compilations (for example, the 1964 Phanerozoic time scale of the Geological Society of London) have been omitted, apparently because the data are on plutonic rocks where stratigraphic age is not precisely fixed. Failure to arrange the abstracts in the second volume in any systematic order is confusing and detracts from their usefulness.

The volumes are well produced, and typographic errors are rare. All references are at the end of the second volume, an arrangement I found a bit inconvenient. In several contributions, the English usage is a bit awkward, apparently because these are by authors whose primary language is not English. The book could have benefited from a more merciless editing by the publisher. Given its cost, this book probably will not be purchased by many other than libraries and geochronologists. If the second volume could be issued separately, I believe it might enjoy wider circulation.

Marvin A. Lanphere is with the U.S. Geological Survey, Menlo Park, CA 94025

Classified

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The successful applicant will have full access to the facilities of NAIC. For atmospheric research these include the high powered 430 MHz incoherent scatter radar, a bistatic 23818 MHz radar for studies of waves in space plasmas. Specific emphasis is on theoretical investigations of wave-particle interactions in planetary magnetospheres and in the solar wind. These investigations are to support the interpretation of data being obtained from spacecraft projects such as Dynamics Explorer, International Sun Earth Explorer and Voyager. The applicant must have a Ph.D. with good qualifications in plasma physics theory and should have some experience in the interpretation of space plasma physics data.

Send a resume and the names of three references familiar with the applicant's work to: D.A. Gurnett, Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242, telephone 319-353-3527.

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Research Assistant in Ice Core Analysis/Ohio State University. Applications are invited for a position at the Institute of Polar Studies, The Ohio State University, beginning October 1, 1983. Primary duties of the position will include operation and maintenance of the Coulter counters in the class 100 clean room, and processing ice and firn samples. Minimum qualifications are BS degree in physical science or engineering and suitable laboratory experience (or equivalent experience). Please send applications, deadline 1 September 1983, to Director, Institute of Polar Studies, Ohio State University, Columbus, Ohio 43210.

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Research Assistant in Ice Core Analysis/Ohio State University. Applications are invited for a position at the Institute of Polar Studies, The Ohio State University, beginning October 1, 1983. Primary duties of the position will include operation and maintenance of the Coulter counters in the class 100 clean room, and processing ice and firn samples. Minimum qualifications are BS degree in physical science or engineering and suitable laboratory experience (or equivalent experience). Please send applications, deadline 1 September 1983, to Director, Institute of Polar Studies, Ohio State University, Columbus, Ohio 43210.

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Geophysicist/University of Saskatchewan. Subject to final budgetary approval, the Department of Geological Sciences will have a new tenurable position in geophysics available July 1, 1984. Applicants should hold, or be about to receive, the Ph.D. or equivalent degree. They will be expected to teach undergraduate and graduate courses in geophysics and to build and maintain a vigorous research program. Excellent research opportunities exist in crustal and exploration seismology and in all fields of mining geophysics. The department, to occupy a new building in 1985, already has well-equipped geophysical and data-processing facilities. Applicants should send a letter outlining their teaching and research goals, accompanied by a full curriculum vitae including the names of at least three referees, to Dr. W. G. E. Caldwell, Head, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Canada S7N 0W0.

Research Scientist/Stochastic Models of Atmospheric Blocking. A Postdoctoral position for the study of stochastic models of atmospheric blocking is available immediately. Send resume and arrange for three letters of recommendation to be sent to: Professor Katja Lindenberg, Department of Chemistry, B-014, University of California at San Diego, La Jolla, CA 92093.

The University of California is an equal opportunity/affirmative action employer.

D'Appolonia/Senior Groundwater Hydrogeologist. D'Appolonia has an immediate opening in their Pittsburgh office for a SENIOR GROUNDWATER HYDROGEOLOGIST with an advanced degree in hydrogeological sciences and/or engineering and experience in hazardous waste projects. Expertise in report writing and ability to supervise hazardous waste projects is important; experience in field exploration techniques, project management, and a working knowledge of hydrologic simulation is required.

Why not put your expertise to work with the energetic people at D'Appolonia.

Qualified individuals should respond in confidence to:

Dr. A.J. Dury
D'Appolonia
10 Duff Road
Pittsburgh, PA 15235

D'Appolonia is an Equal Opportunity Employer M/F/H.

Research Professor in Marine Geoscience/University of Rhode Island. The Graduate School of Oceanography invites applications for a research professorship in Marine Geoscience whose salary and rank are negotiable. Preference will be given to candidates who have clearly demonstrated abilities and interest in, but not necessarily limited to paleomagnetism. The position is funded by contracts and grants, however the research professor holds full faculty rights in addition to other benefits. The paleomagnetic facility at GSO is fully equipped, fully operational and oriented towards rapid measurement of large numbers of soft sedimentary samples. Applications are now open for the position which will become available about January 1, 1984.

Send letters of application, resume, and names and addresses of three professional references to: Roger L. Larson, Graduate School of Oceanography, University of Rhode Island, Narragansett, Rhode Island 02882.

An affirmative action/equal opportunity employer m/f.

Visiting Research Scientist Radio Emission Processes

Applications are invited for a visiting research scientist position in the Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa.

This position is intended to support a multidisciplinary study of planetary, solar and astrophysical radio emission processes funded by the NASA innovative research program. Applicants must have a Ph.D. with a good theoretical background in basic plasma physics and experience in either experimental or theoretical studies of planetary, solar or astrophysical radio emissions. Our intention is to favor established scientists with research experience in this area, although junior scientists with an appropriate background will also be considered. The salary will be commensurate with the experience level. The appointment can be for any period up to one year, with a possibility for extension to a second year, depending on funding constraints.

Send curriculum vitae and a list of three references to:

D. A. Gurnett
Department of Physics and Astronomy
The University of Iowa
Iowa City, Iowa 52242
Telephone 319/353-3527.

The University of Iowa is an affirmative action/equal opportunity employer.

RESEARCH POSITIONS AVAILABLE

The Lunar and Planetary Institute is a center for Planetary and Earth Science research associated with NASA programs. The Institute presently has 2 to 3 positions available at the postdoctoral and staff scientist levels. Appointments are initially for one year with the possibility of renewal for additional years.

Areas of current research interest at the Institute include: geophysical analysis of global data sets; planetary geology, including the analysis of surface images and theoretical and experimental studies of impact cratering; terrestrial remote sensing with special reference to volcanic phenomena; planetary tectonics, especially of Mars, Venus and the Earth; and the early crustal genesis of terrestrial planets.

Applications from specialists in all areas of planetary and earth science are invited and will be particularly welcome from researchers whose work augments or complements existing programs.

LPI facilities include a computer center equipped with a VAX 11/780, an image processing facility equipped with a Gould/DeAnza IP 8500, a geophysical data facility with interactive graphics capability, extensive library holdings in the geosciences, and a major collection of space photography.

The LPI, funded by NASA through the Universities Space Research Association, is located adjacent to the NASA/Johnson Space Center near Houston. Salary and benefits are competitive and attractive and depend on individual qualifications. Respond before Sept. 30, 1983 to:

Director's Office, LPI
3303 NASA Road 1
Houston Texas 77058

An equal opportunity employer

CNOC Chair in Mapping, Charting and Geodesy (Hydrography)/Department of Oceanography, Naval Postgraduate School, Monterey, California.

Under the sponsorship of the Commander, Naval Oceanography Command (CNOC) a Chair in Mapping, Charting, and Geodesy (MC&G), with emphasis on Hydrography, has been established in the Department of Oceanography, Naval Postgraduate School (NPS). The objective of the Chair is to promote MC&G studies and research by students and faculty, and to encourage acquaintance of the Chair with Navy needs in the MC&G field.

The incumbent's principal responsibilities will be to conduct research and to supervise student thesis research of a type that will interface the Hydrographic Sciences Program of NPS with the MC&G needs of the Navy. A favored theme in research applicable to operational hydrographic survey problems.

Academic excellence and the ability to bring forth new ideas are the primary considerations in the selection process. The term of appointment will normally be for twelve month periods (1 October to 25 September); however, exceptions will be considered. Candidates may be members of the academic, federal, or private sectors. Where appropriate, Intergovernmental Personnel Agreements are applicable. For further information, contact Professor D.N.K. Bowers, Chairman, Department of Oceanography, Naval Postgraduate School, Monterey, California 93943, telephone number (408) 646-2677. Send curriculum vitae/resume information and letters of interest to forerser to the above address.

The Naval Postgraduate School is an Equal Opportunity/Affirmative Action Employer.

Anticipated Opening/Research Associate. The Coastal Ecology Laboratory Center for Wetland Resources, LSU, has an anticipated opening beginning October 1983. Rank and salary dependent upon qualifications and experience. Ph.D. in coastal hydrodynamics and nutrient transport is preferable. Responsibilities will include development and application of computer models and water quantity and quality aspects, supervising computer programming and preparing technical reports. Background in hydrology, ecology and estuary will be helpful. Experience in statistical, mathematical and numerical analysis is desirable. Send transcript, resume and three letters of recommendation to: Dr. Flora C. Wang, Department of Marine Sciences, Louisiana State University, Baton Rouge, LA 70803 before August 10, 1983.

LSU is an equal opportunity employer.

Chairman—Department of Geological Sciences, Wright State University. The Department of Geological Sciences, invites applications for the position of Chairman, to be appointed September 1984. We seek a thought individual with administrative talent and appreciation for research and professional educational activities. Rank is at the full professor level and no restrictions have been placed on area of specialization. The department is active with 12 faculty and an emphasis on professional practice maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:

Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435.

Wright State University is an affirmative action equal opportunity employer. Closing date for the position is October 31, 1983.

RESEARCH ECONOMIC GEOLOGIST

The Department of Mineral Sciences at The American Museum of Natural History is seeking applicants for a curatorial research position in Economic Geology. Major responsibility is to carry out a vigorous research program involving field and laboratory studies on the origin and development of ore deposits anywhere in the world. Close working relationships with other researchers to broaden the scope of the work are encouraged. Involvement with graduate students, if desired, is also possible. Minor responsibilities include some collections development and public programs (symposium or exhibition). The position offers the freedom and support to carry out major research projects on a large scale, unfettered by major administrative or academic responsibilities.

The Department has excellent laboratory facilities including an automated electron microprobe, X-ray facilities, sample preperation laboratory, photographic and graphic support, and computers. A PhD in Economic Geology is required and the position is open to persons of any rank, with salary negotiable.

Candidates should submit a resume (including a statement of research interest), salary requirements, and the names of three references by October 16, 1983 to:

Dr. Martin Prinz, Search Committee

THE AMERICAN MUSEUM OF NATURAL HISTORY
79th Street at Central Park West, New York, N.Y. 10024

An equal opportunity (M/F/H) affirmative action employer.

AGU

Waldo E. Smith Receives First Award of His Namesake Medal

Waldo E. Smith

Citation

This evening marks the first presentation of the American Geophysical Union's Waldo E. Smith Award. While all other AGU awards and honors are given for excellence in scientific research in one or another of the geophysical disciplines, this award is different.

The Waldo E. Smith Award is given for dedicated and extraordinary service to geophysics and AGU. It is the principal purpose of this citation to show why it is particularly appropriate that an award for service to American geophysics should be called the Waldo E. Smith Award. A secondary objective, aimed at those present tonight, is to introduce the first recipient of this award, Waldo E. Smith, Executive Director Emeritus of AGU.

Early in 1944, Dr. J. A. Fleming, AGU's General Secretary, approached Waldo with an offer that he become the Union's first full-time Executive Secretary. The Union then had an employee head count of 1½, with 2000+ members divided into 8 sections—Geodesy, Seismology, Terrestrial Magnetism and Electricity, Hydrology, Meteorology, Oceanography, Volcanology, and Tectonophysics—and was housed in borrowed office space in the attic of the Carnegie Institution Administration Building. On September 22, 1944, Waldo was duly appointed Executive Secretary of AGU, a position which he held until his retirement in 1970 (the position title was changed to that of Executive Director in 1967). The initial appointment was accompanied by Fleming's strong admonition that "Waldo should not concern himself with building an empire." The 1944 AGU auditor's report, reproduced below in toto, recorded the exact physical dimension of the empire that Waldo had agreed to manage.

Equipment owned by the American Geophysical Union

One 18-inch primer Burroughs typewriter, ser. No. 80A252450	$190.80
One 10-inch elite Royal typewriter, ser. No. KHM-2076351	$100.31
Two 4-drawer, 5×8-inch steel filing cases (gift)	$ 0.00
Two steel posture chairs	$ 22.00
One Globe-Wernicke, 2-pedestal flat-top steel desk, 60×34-inch	$ 49.18
One Triner postal scale, 4 lbs. by 1/2 oz.	$ 16.20
One Arrow stapler	$ 6.75
	$385.24

Using the above as a base, Waldo went to work, and hard work it was by all accounts. For the next 25 years Waldo continued to build AGU, and by the time of his retirement AGU existed largely in its present form and substance. Consider Figure 1 where the growth in AGU statistics for the Waldo era has been plotted. During his tenure the Union grew from 2000+ to 10,000+ members, the staff grew from 2½ to 40 full-time paid employees, and the journal pages published per year expanded from 482 in 1945 to 17,032 in 1970.

But rather than just considering the numbers of Figure 1 let us translate some of them into entities, and see just what these statistics have actually meant to American geophysics.

In 1959 the *Journal of Geophysical Research* (JGR) was incorporated into AGU. (Previously, JGR was an unofficial publication of the Carnegie Institute). Phillip H. Abelson and J. A. Peoples, Jr., were the first JGR/AGU editors. In its first year under the AGU masthead, and with the help of an NSF grant, JGR published 2460 pages; by 1962 this count had risen to 5398; and by 1970 to 7696.

Water Resources Research first appeared as a quarterly in 1965 with Walter B. Langbein as editor and with a total page count of 586; by 1970 this count had risen to 1806 pages with bimonthly issues and was well on its way to being the premier research journal for water.

Reviews of Geophysics first appeared in 1963, with Gordon J. F. MacDonald as editor. As a matter of policy the number of pages published by this journal has always been a fairly tightly restricted percentage of the number of pages in JGR, but nevertheless Reviews likewise grew from 665 pages in its first year to 864 in 1970 (by which time it was called *Reviews of Geophysics and Space Physics*).

Further, it was in the Waldo era that AGU's journal translation program started. First came the journals of *Izvestiya, Academy of Sciences, USSR (Physics of the Solid Earth* and *Atmospheric and Oceanic Physics*—IZVE/IZVA) in 1957, but by 1965 the number of translation journals being published by AGU had risen to seven. Similar success sagas are associated with AGU's books and monograph series, and all can be said to owe their existence to the friendly environment created for them by Waldo E. Smith. AGU journals and books are highly respected throughout the scientific community, and they are still one of the few real bargains existing in the scientific literature.

Keep in mind that this highly successful publication program was accompanied and orchestrated from 1944 to 1970 by the omnipresent Waldo E. Smith, who acted in this period (depending upon one's point of view) as either the midwife or as the despot, but in any case as the one who always managed to see to it that what had to be done to assure success was indeed done.

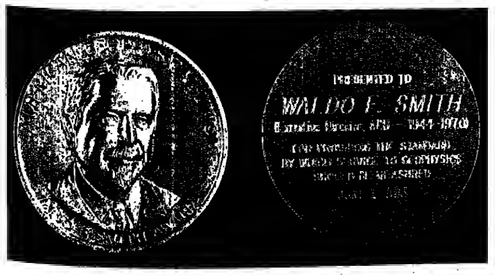
In addition to the above list of obvious, major accomplishments, AGU has benefited from some of Waldo's lesser known political and personal abilities. For instance, on October 4, 1957, "Sputnik" appeared, and with it a new, enhanced interest in the science of space. The AGU Council was split on whether or not "space" could be considered as geophysics, but in the end Waldo's pragmatic view "that geophysics is whatever we say it is" prevailed, and by a majority of one vote the Council allowed for the formation of a Section of Planetary Sciences. Dr. J. A. Van Allen served as the first Section President for the new section.

Further, in spite of all the growth and activity that surrounded Waldo he never forgot that AGU was its members. It is reputed that he knew all the members by name, by sight, and by scientific interest. This must be an exaggeration, but I do know that in my own case I met Waldo very soon after joining the Union because he took the trouble to introduce himself to me at the very first meeting that I attended. Subsequently he never forgot my name, or for that matter the subject of our original conversation. In this regard, I do not believe that I received special treatment, and in fact while researching this citation I received many confirmations of this beloved, ego-boosting ability which Waldo used upon the membership.

However, let us be fair; I did uncover one instance of fallibility. Like a good coach, Waldo always addressed staff members by their last names, and like AGU member names, once learnt these were never forgotten. However, one employee, Miss Chamberlin, married and changed her name. Waldo knew this, but his usually faultless memory-banks exhibited a defect. For 2 years Waldo never addressed that staff member. But the story does have a happy ending, because eventually Helmut Landsberg did manage to teach Waldo how to pronounce Holovick, and communication was restored.

But let us return to the business at hand. AGU now has 15,080 members, of whom 61.56 percent joined the Union after Waldo E. Smith's retirement. The AGU staff now numbers nearly 70 of whom only a handful have tenures that date back to the Waldo E. Smith era. AGU's annual publication revenues now total $5,900,000. We are housed in our own building, and our annual meetings produce presentations that number into the thousands. In summation, when Waldo E. Smith retired in 1970 he left the Union as a vibrant, growing organization.

AGU (cont. on p. 464)



Nominations for Medals and Awards

William Bowie Medal. Awarded for outstanding contributions to fundamental geophysics and for unselfish cooperation in research.

Maurice Ewing Medal. Honors an individual who has led the way in understanding the physical, geophysical, and geological processes in the ocean; who is a leader in ocean engineering, technology, and instrumentation; or who has given distinguished service to the marine sciences.

Robert E. Horton Medal. Given for outstanding contributions to the geophysical aspects of Hydrology.

James B. Macelwane Awards. Up to three awards are given each year for significant contributions to the geophysical sciences by a young scientist of outstanding ability. Recipients must be less than 36 years old.

Letters of nomination outlining significant contributions and curriculum vitae should be sent directly to the appropriate committee chairmen: *Bowie Medal* - Eugene M. Shoemaker, U.S. Geological Survey, 2255 Gemini Drive, Flagstaff, AZ 86001; *Ewing Medal* - Robert O. Reid, Department of Oceanography, Texas A&M University, College Station, TX 77843; *Horton Medal* - R. Allan Freeze, Department of Geological Sciences, University of British Columbia, Vancouver, B.C., Canada V6T 1W5; *Macelwane Award* - J. Freeman Gilbert, IGPP A-025, University of California/San Diego, La Jolla, CA 92093.

Deadline for Nominations is November 1, 1983.

Nominations for 1984 AGU Fellows

Nominations for Fellowship in the Union are being sought by the Fellows Committee and the Section Selection Committees. Nominees for Fellowship should be scientists who have attained acknowledged eminence in a branch of geophysics. The total number of Fellows elected each year cannot exceed 0.1% of the total membership.

To be considered by the Committee, nominations for Fellowship in AGU *must be made on the form below.* If more space is needed, attach a separate sheet.

AMERICAN GEOPHYSICAL UNION
Nomination For Fellowship

Name of Nominee _____ Name of Sponsor _____

Personal Data on Nominee

Business Address (including Position held) _____

Date and Place of Birth _____

Education (degrees, institutions, major field) _____

Professional Record (including special honors) _____

Membership in other Scientific Organizations _____

Attach a list of most significant publications (not abstracts, book reviews or papers which have not yet been accepted for publication).

Sponsors Evaluation of Nominee

Attach a supporting statement which must include: (1) An indication of the length and nature of your acquaintance with the nominee; (2) the Nominee's contributions to the field to date; (3) your evaluation of the nominee's scientific ability; (4) a one-line citation, "For . . . . . ", summarizing why the nominee should be elected a fellow.

Signed _____ Date _____

Sponsor's Title and Affiliation _____

For a list of current Fellows, call or write AGU.

Send nominations for forwarding to the appropriate Section Selection Committee to:

AGU Member Programs
2000 Florida Avenue, N.W.
Washington, D.C. 20009
Telephone toll free 800/424-2488
or 462-6903 in the Washington area

Deadline: September 19, 1983

AGU (cont. from p. 463)

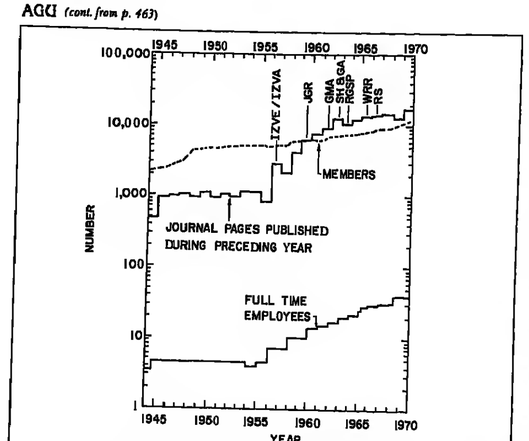


Fig. 1 AGU statistics for the Waldo E. Smith years, 1944–1970. Journal pages published are raw data totaled without regard for varying page sizes.

The 1982 AGU Council formally recognized the adage "that there is more to doing science than doing science" when it established an award in recognition of dedicated and extraordinary service to geophysics. The award, which includes a medal, is to be given no more frequently than every other year. It is most appropriate that these medals to be given by AGU for service to geophysics should bear the likeness of Waldo E. Smith upon one side of them, because for over a quarter of a century AGU, American geophysics, and Waldo E. Smith were synonymous.

Like William Bowie, who received the first Bowie Medal, Waldo E. Smith is present to receive the first of the medals that bears both his name and his portrait. For service to AGU and to geophysics, Waldo E. Smith has provided the measure and the standard by which all who would follow must be judged. It is with pleasure and with some sense of poetic justice that I now turn to our current AGU President, Dr. J. A. Van Allen, and ask him to make the formal presentation of AGU's newest award, the Waldo E. Smith Award for outstanding service to geophysics.

James R. Wallis

Acceptance

As I stand here before you, I feel both very humble and very honored. It would seem that an executive officer of such an organization as the AGU gets much credit that he does not deserve: this accrues not only from his staff, but even more largely from the work of competent devoted officers, committee chairmen and members, and the membership as a whole. It is through them that the executive's efforts are meaningful. I recall that back in 1945 when I arranged my first annual meeting. During the war years, we had to receive permission from some wartime government agency to hold such a meeting. This was not difficult; earth sciences were already recognized as important to the war effort. The section secretaries and their committees did a creditable job of arranging a good program. Then I had a strange feeling in the pit of my stomach: What if no one but the speakers came? I think that the record will show that some 800 or more came. And I had a feeling of elation as the meeting drew to a close that the meeting had been a success. Thus it was, after every succeeding annual meeting.

But there were other problems. AGU was started by the National Academy of Sciences—National Research Council in 1919 as the U.S. National Committee of the International Union of Geodesy and Geophysics organized by the International Research Council (now ICSU). Originally it had 65 members appointed to cover what was then deemed to span geophysics. During the 1920's, the number was increased to 75, then 100, then 200, and after the financial crash of 1928, the limit was eliminated and most anybody who was willing to contribute $2 per year was taken into membership. The annual reports and papers presented at the meetings had been published in the NRC series, but after the crash, the NRC cut back on its publishing program and gave the AGU $400 annually, which with the $2 contributions from the members, growing slowly in number, gave a small working fund.

That was the point that the ingenuity of Dr. John A. Fleming who served as General Secretary of AGU from 1925 until 1947 (and then became Honorary President for Life) came into the picture. He pioneered in the preparation of master copy by typewriter with reproducdon by offset which continued into the 1950's, effectively using the limited funds available. The *Transactions* came out each year, usually in two or more parts. In 1945, when I came into the picture, the *Transactions* became a bimonthly. These old annual volumes contain many papers deemed to be classics and are very choice. Free copies were sent to all members who had contributed and to some 800 libraries without charge.

I never quite heard why or how I became the first executive officer. Dr. Fleming was my mentor, a relationship of which I am still very proud. There was a call for candidates, a selection committee functioned, but in the end, Dr. Fleming made the selection. It was not with rancor, but with real admiration that the organization was sometimes referred to as the John A. Fleming Geophysical Union. He bore a heavy load of work as a volunteer, a devoted volunteer, for over 20 years, editing, corresponding: the prime mover. And he was a perennial optimist, especially with respect to geophysics and most especially the AGU. But the burden became too great, and the membership had grown to about 2,200. He and other officers had sought and received the promise of a grant of $20,000 over a three-year period from the Rockefeller Foundation to establish a full-time secretariat, on the condition that another $10,000 be raised by the membership. So, at the outset, the annual receipts from the membership was 2,200 x 2, or $4,400. About 90 percent of the libraries subscribed. There was lengthy discussion whether the membership would accept a 50 percent increase in dues, from $2 to $3. Academic geophysics had a very limited constituency. Would we lose 90%? Or 50%? Or very few? The loss, as I recall, was about a normal 2%. Freeborn Johnston, a member of Dr. Fleming's terrestrial magnetism staff, was membership chairman, and in a bit over a year, he sent out some 15,000 personal notes to prospective members; that brought in some 1,500 new members. And so AGU, always financially poor, struggled on.

Then along came the IGY. Early in the 1950's, our incumbent president, Dr. Van Allen, and some of his colleagues felt that a third International Polar Year (following the first in 1882–83 and the second in 1932–33) might be in order and named it the International Geophysical Year (IGY). This idea met with enthusiasm abroad, and plans were furthered at the Rome meeting of the IUGG in 1954. The IGY became a phenomenal success.

Celebrating the 25th anniversary of the IGY at the recent meeting of the NAS, President Frank Press [formerly president of AGU) expressed the idea that this IGY endeavor might truly be unique. It was based on the long developing idea that it was necessary that the earth as a whole should be given serious attention. Dr. Herbert Friedman of the Naval Research Laboratory presented a paper, "The Legacy of the IGY (One Hundred Years of International Cooperation)." There had been the growing feeling throughout the years that the interrelationships in geophysics transcended any one field. Friedman noted that Lieut. Karl Mayprecht of Austria, in the 1870's, proposed what became the First International Polar Year (1882–83) that drew geophysicists together.

Now, coming back to the 1954 IUGG Rome meeting: Clare Boothe Luce was the U.S. Ambassador to Rome. An American reception was held in an embassy house. It was my pleasant duty and honor to present the various foreign delegates to her. From time to time on, it seemed to me that *Time* gave frequent favorable word concerning the IGY effort.

A quarterly, *Terrestrial Magnetism and Atmospheric Electricity*, had been privately published by the director of terrestrial magnetism of The Carnegie Institution of Washington, and Dr. Fleming had that under his wing also. When Dr. Merle Tuve became the director of terrestrial magnetism, and thus editor of the quarterly, he changed its name to the *Journal of Geophysical Research* (JGR) and in 1950 turned this title and the quarterly's good will over to AGU. With the aid of NSF grants, AGU issued JGR monthly, then semimonthly, and then, as now, three issues a month. Books resulting from the IGY work also needed publishing, and there was need to know more about what was going on in geophysics in the USSR. The NSF gave us grants to translate their best geophysical journals. New journals were started, as noted by Dr. Wallis. At last geophysics had a real and growing constituency. Each year we were able to save a bit, and we established a reserve fund. It had been my hope that a reserve equal to a year's budget might be developed, but during the closing years of my incumbency we got up to 1/3 of the annual budget, and I think that that is about the present ratio. Of course, as the budget went up, due to inflation and for other reasons, the amount increased.

Inflation struck with full force just after I retired in 1970, and presented a new set of problems to the officers and to my successor which I think were not very well, but I would like to see that reserve ratio increase and a distinct reserve fund established, not for use at operating purposes but to meet new opportunities and challenges. It was on this basis that I have joined the volunteer effort to raise such a fund. You have received appeals regarding this effort from time to time and there has been considerable response. But it is a long hard pull. Earlier we missed opportunities, and other groups have filled some of those gaps, tending to dissipate efforts toward the integration of a continuing broad unity in geophysics.

Dr. Wallis told you about the critical moment when the motion adopting Dr. Van Allen's report to have AGU embrace the environment of the earth in space won by a single vote. It gave me that earlier, sinking feeling again that I got at the time of the first annual meeting: What would AGU be like today if that one rate had gone the other way?

It has not been all smooth sailing, as some of you younger members may feel in the present situation. AGU is no longer poor financially, but neither is it wealthy. AGU has no endowment and has not been in a position to establish a foundation. Meeting current needs has always been a real challenge. We need faith and hard work to have the joy of success. Dr. Wallis just told you that two-thirds of the membership today became members since I retired in 1970. I look at attendees of our meetings, and I find many bright young faces. This bodes well for the future. Challenges will continue; may you carry on in the traditions of the past to an even greater future.

A lot more could be said, but those critical years were pretty well chronicled in the *Transactions* of 1954 (pp. 1 to 47). See if your librarian can dig the issue out.

One regret that I feel today is that my faithful Martha, my lovely lady for 55 years, could not have been here tonight to share this moment of joy with me. But I am glad that my daughter, Carol, could fly up from Richmond this afternoon to be here.

Thank you.

Waldo E. Smith

Meetings

Announcements

Environmental Biogeochemistry

On October 9–15, 1983, Santa Fe, N.M., will host the Sixth International Symposium on Environmental Biogeochemistry. As a forum for biologists, chemists, and geologists, the symposium will deal with topics ranging from biological evolution to observations of microbes living in the cracks of stones found in the Antarctic. Microbes living in ground-water, a subject that has not been given much attention, was added recently to the agenda.

On October 8, preceding the five symposium sessions, various field trips will be offered to the Carlsbad Caverns, the Kennecott Chino Mine, Sangre de Cristo Mountains, and the Jemez Springs.

Contact James A. Brierley, Department of Biology, New Mexico Institute of Mining and Technology, Socorro, NM 87801, for more information.

Climate and Environment

Changing climate and its effects on agriculture and environmental quality will be the subject of the 12th Annual Conference of the Illinois Department of Energy and Natural Resources to be held September 13–14, 1983, at the University of Illinois at Urbana. The conference, entitled "Illinois Climate: Trends, Impacts, and Issues," will deal with such topics as acid rain, the effects of increasing carbon dioxide in the atmosphere, and the relationship of agricultural pests to weather and climate.

For more information contact Mae Maxwell at the Office of Conferences and Institutes, University of Illinois, Urbana, IL 61801 (telephone: 217-333-2883).

Space and Climate Conference

As part of its biennial meeting, June 25 to July 7, 1984, in Graz, Austria, the Committee on Space Research (COSPAR) of the World Climate Program (WCP) is organizing a special Symposium on Space Observations for Climate Studies. One of the largest scientific projects of the current century, the WCP is both international and interdisciplinary in scope.

Recognizing that the key component of the WCP's observational program will be based on satellite measurements, the symposium will focus on the current observational requirements of the program, on results and interpretations of recent observations, and on future observational requirements.

Invited and contributed papers will cover such topics as basic atmospheric variables (temperature, pressure, humidity, winds, and precipitation), clouds, the earth's radiation budget, the oceans, the cryosphere, land and surface hydrology, detection of climatic change, and space data (requirements, management, and international coordination). In a special opening session, scientific leaders of the World Climate Research, Impact, Applications, and Data programs will provide a summary of the current status and data requirements for these programs. The proceedings of the symposium will be published.

For further information contact S. Ruttenberg, Secretary, COSPAR Commission A, NCAR, Boulder, CO 80307.

Cosponsors of the symposium include the World Meteorological Organization, the International Association of Meteorology and Atmospheric Physics, the United Nations Environment Program's Scientific Committee on Oceanic Research, the International Union of Radio Science, and the Scientific Committee on Anarctic Research.

Meeting Report

1983 AGU Spring Meeting Report

Attendees at ACU's 1983 Spring Meeting once again found Baltimore to be a very hospitable, convenient, and delightful place, and the Convention Center to be an excellent meeting facility. There were 2100 attendees, and 1400 papers were presented. Changes to the program and additional, late, and revised abstracts are printed below.

Papers Not Presented

U32–01A, R. K. Cormick.

A12–07, W. L. Flowers et al.; A12-12, P. Aharon.

GP11–01, D. L. Lin; GP11–02, P. H. Moose et al.; GP12–14, B. G. Thompson; GP21–04, C. E. Barton; GP22–10, R. J. Johnson et al.

H11–01, S. R. Kshirsagar et al.; H21–05, D. S. Finan et al.; H22–01, P. Blazcyk; H22–01, S. Rasmaseahan; H31B-16, S. T. Kim.

O11A-08, J. D. Hawkins et al.; O31–05, D. J. Fornari et al.; O32A-06, F. C. Newman et al.; O32A-07A, J. R. Schubel; O32A-07B, F. Bohlen; O32B-02, M. R. Carnes; O41A-06, R. Ahmstedt et al.; O42A-10, K. Kim et al.; O61B-14, R. G. Ingram.

S11B-05, B. Valez et al.; S12–05, C. Lamesle et al.; S32–04, T. R. Visvanathan; S41–01, S. M. Day et al.; S42–02, I. R. Sampaio et al.; S42–05, J. P. Todoeschuck et al.; S51–03, J. D. Phillips et al..

SA51–05, W. Swider; SA51–06, B. J. Wilkins et al.

SM22E-22, W. A. Kolasinski et al.; SM41B-03, J. F. Fennell et al.

SS22–08, J. A. McKinnon et al.; SS42–08, L. D. Smith et al.

T22A-01, M. C. Roufosse; T32–05, J. Schedl; T51–03, R. K. O'Nions et al.; T56–06, F. M. Richter.

V11A-12, D. C. Noble; V12A-05, L. A. Le Bel et al.; V22A-02, K. T. M. Johnson et al.; V31B-06, J. W. Prescott et al.; V32A-06, W. H. Zoller et al.; V32A-09, D. L. Finnegan et al.; V42B-01, J. F. Stebbins et al.

Newly elected AGU Fellows receive their certificates from AGU President J. A. Van Allen.

Waldo E. Smith (left), first recipient of the Waldo E. Smith Award, is congratulated by AGU President J. A. Van Allen.

John Maxwell (far left) enrolls as an AGU Individual Supporting Member with AGU Gift Steering Committee members (left to right) Charles Whitten, Earl Droessler, and Morton Rubin.

Panelists at the Union session on Verification of Nuclear Test Ban Treaties answer questions from the audience.

Late and Revised Abstracts

Union

U51-01A INVITED

Satellite Data and Geology

RONALD E. KOBRICK (Conoco Inc., P.O. Box 4800, The Woodlands, TX 77380)
(Sponsors Frank Eden)

Earth scientists recognize the benefit of different perspectives when studying features of varying scales. We have witnessed many technological advancement to "see the woods for the trees" or, in our terms, "the mountains for the outcrop." Today, we call it the "synoptic viewpoint." We have progressed through photography from mountaintops, to air balloons, airplanes, rockets and even the Skylab platform orbiting satellites. Throughout this revolutionary period we have experimented with many different sensors as well as several sources besides the sun.

The fundamental influence of satellites on the earth sciences comes precisely from our original objective--obtaining a better synoptic view. The most important secondary benefits accrued from better spatial resolution (detail on the ground) and better spectral resolution ("seeing" features outside our normal visible wave length range). Recently, we also have benefited from airborne and space-borne systems that penetrate the earth's surface and detect information in the third dimension that geologists call direction.

In this paper we will briefly review the earth science-related information provided by the many earth-orbiting satellites that have successfully orbited the earth. We will discuss the uses made of such information, estimating its impact in each major discipline.

There are inherent limitations in the accuracy of all remotely sensed data, and in the ultimate value of such information to any earth scientist. Some of these limitations are overlooked and/or understated. Depending on who is doing the talking, this can hurt the credibility of a report; a scientist, and even the whole field of science. Some of the most critical limitations, speculate on the likelihood of overcoming or at least diminishing them, and then discuss the credibility issues that have evolved.

Finally, as all successful explorers indulge in risky ventures, I will extrapolate from the present into the future and predict the influence of satellites on our science in 10 to 30 years. The effect of the sad disarray at this nation's civilian satellite program will be blunted by the relatively aggressive programs in Japan, France, and elsewhere.

Geodesy

G21-12A

Strain Simulations for Analysis of Geopotential

F.J. LERCH
RAY NEREM (both at: Goddard Space Flight Center, Greenbelt, MD 20771)

Computer simulation results for the Geopotential Research Mission (formerly Geosat) have been obtained which support accuracy goals of the mission, namely 3 with a half-wavelength resolution of 1 degree. The computer simulations were performed with detailed precise satellite doppler tracking (at vacuo/and between two stations) for 360 lm to a polar orbits and separated by 360 lm to a drag-free spacecraft for a 4-month mission lifetime. Results from studies have been favorable as follows: (1) the recovery of spherical degree and order 36 gave an accuracy of 2 to 5 orders of magnitude better than current knowledge; (2) recovery of gravity anomaly fn a local region (at 2 to 20° spans) to the presence of unmodeled errors (both heights and 4 spans) for the gravity anomaly for 1° x 1° blocks and the inversion of the regions (3) the recovery of 1/2° x 1/2° blocks of geoid height and gravity anomaly to a local accuracy of 1 meter and 3 milligals, respectively, with the use of algorithm analysis, combinator (4) 5 cm recovery of 1° x 1° block geoid and 3 ugal for gravity anomaly over the trench region to [3 confirmed the results of this study which satisfy accuracy goals of the Geosat mission. (5) a Poeltier [feeling" features outside our normal visible wave length range). Recently, we also have benefited from airborne and space-borne systems that penetrate the earth's surface and detect information in the third dimension that geologists call direction.

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G51-12A

Geoid Anomalies over the Mascarene Ridge Complex Indicate an Unexpected Subducted Slab

LARRY RUFF (Dept. Geological Sciences, University of Michigan, Ann Arbor, MI, 48109)
ANNY CAZENAVE (GRGS-CNES, 18 Ave. Edouard Belin, Toulouse, 31055, France)

The boundary between the Pacific and Indian plates is presumably coincident with the seismically active Mascarene Ridge complex (hereafter MRC), which lies between south Island (New Zealand and the Macquarie spreading center. Along the easterly north striking MRC, the RNZ relative plate velocity model (Minster & Jordan, 1978, JGR, 83, 5331) predicts oblique convergence in the north, grading into strike-slip motion in the south. The focal mechanisms of the large recent earthquakes along the MRC are consistent with the RNZ model. It is therefore puzzling that the physiographic expression of the southernmost MRC is the Hjort trench which as mapped by the calibrating pulse train. In this paper we used to determine the necessary phase information for all ions within the passband.

G42-12B

Tilt at Pinon Flat Observatory, California.

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A. Sylvester (Department of Geological Sciences, UCSB, Santa Barbara, CA 93106)
T. Owen (Hallett Labs, Cambridge University, Cambridge CB3 OEZ, England)
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G.G. Jackson (IGPP, UCLA, Los Angeles, CA 90024)

We are operating three 533 meter fluid tiltmeters and a 250 m deep borehole tiltmeter side-by-side at Pinon Flat Observatory, CA. In addition, we have installed levelling benchmarks in a 2500 m loop that includes the tiltmeter baseline. We surveyed parts of the loop ten times, and the entire loop five times since Oct. 1978.

We hope to observe aseismic tectonic tilting on one or more tiltmeters with reasonable agreement. We have not yet achieved this goal, but we have learned much about tilt measurements. The tiltmeters agree well at tidal periods (to within a few percent), but not as well at longer periods. During the period 21 Oct 81 through 27 Mar 82, the apparent drift rates ranged from 0.2 to 4 microradians per year. One of the tiltmeters suffered from large temperature effects. Recent improvements should reduce the drift rates of some of the instruments. Data collected since 27 Mar 82 appear comparable to the previous data, except that heavy rainfall caused obvious transients.

Random benchmark motions of up to 1 cm seem the dominant errors in the leveling data. Therefore, we established several special benchmarks anchored at about 10 m depth. Using these monuments, we can estimate the dit rate to within about 0.5 microradian per year.

G51-12A

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The boundary between the Pacific and Indian plates is presumably coincident with the seismically active Mascarene Ridge complex (hereafter MRC), which lies between south Island (New Zealand) and the Macquarie spreading center. Along the easterly north striking MRC, the RNZ relative plate velocity model (Minster & Jordan, 1978, JGR, 83, 5331) predicts oblique convergence in the north, grading into strike-slip motion in the south. The focal mechanisms of the large recent earthquakes along the MRC are consistent with the RNZ model. It is therefore puzzling that the physiographic expression of the southernmost MRC is the Hjort trench which at 5 km is compared to the 3.5 km depth of the surrounding seafloor. Plate tectonic reconstructions of the southern Pacific indicate that the Hjort trench region should have been a convergent plate margin. As small crust can occur along large transform zones, can we trough to occur along large transform zones, can we assume that the Hjort trench is a strike-slip feature? We employ geoid anomalies, obtained from SEASAT altimetry data, to address this question. Previous studies have shown that high-resolution geoid profiles across subduction zones and fracture zones are distinctly different. Therefore, observed geoid anomalies will help discern the nature of the MRC plate boundary. Our main result is that the geoid anomalies associated with the northernmost Hjort trench have the characteristic shape and wavelength of subduction zone anomalies. Large geoid amplitudes can be explained by a shallow, high density slab beneath the east. This interpretation requires that the plate tectonic models for this region be reassessed. The motions in the MRC region may not have followed those of the two large neighboring plates. This feedback between salinity-

Hydrology

H42-04A

Assessment of Uncertainty of Fracture Flow Simulation Utilizing A Single Expansion of The Equivalent Porous Media Concept

James Yeary (Ertec Western, Inc. Long Beach, CA 90807)
Michael Teubner (Ertec Western, Inc. Long Beach, CA 90807)

A single equivalent porous media model is proposed and utilized to investigate the uncertainty of fracture flow analyses. The proposed model is a single extension of the equivalent porous media concept. The analyses address the problems the uncertainty of fracture flow parameters, the definition of fracture geometry, and the definition of primary-fractured connectivity that are required to perform fracture flow analyses.

The [illegible] concept to the range of uncertainty in the aggregate media and the implications on transport in a fracture media. The model is, however, limited in utility by the simplicity of its formulation.

Ocean Sciences

O12A-09A INVITED

SAR Measurement of Wave Fields with Multiple Directional Components: Observations & Comparison

John L. Wessely, Martha P. Smith and David J. Kapotitana (Stanford Center for Radar Astronomy, Stanford, CA 94305)

Measurement of ocean wave directional distributions is difficult since pitch-roll buoys provide only crude directional information and wave-rider buoys, no directional information at all. Arrays can provide directional information, but are difficult to deploy. Synthetic aperture radar (SAR) images of ocean wave fields can be used to sense wave directional distributions, but the technique has important limitations. We explore the ability of SAR to measure wave directional distributions using digitally processed images at wave lengths near the limit of Fowle (SW of the Shetland Islands). The image contains resolvable with a single dominant component and with multiple directional components generated by refraction and diffraction near the island. We compute normalized 2-dimensional spectra at pertinent images to address two issues. First, how well can SAR sense wave systems with multiple directional components? Second, how well does current SAR theory of ocean wave imaging describe the degradation of SAR resolution for wave fields with multiple directional components? We compare experimental results with the theoretical predictions of Alpers, Ross & Rahreach and of Jain, who addresses the multiple component case spatially.

O21-12A

Sea Level and Circulation

Keith R. Thompson (Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1)

Sea level and transport variability off the North Atlantic are examined in the frequency range 0.03 – 0.04 cpd (<28-day). The sea level data were recorded at 21 coastal and island stations (<60N – 19N). The Sverdrup transports are determined from monthly wind stress distributions.

Each sea level series is corrected for the influence of local air pressure and local wind stress. A crude sea level variation is found along the eastern boundary of the North Atlantic from Reykjavik (<65N) to Cayenne (<5N). Along the east coast of the United States and Canada there are two distinct regions of sea level variability, separated by Cape Hatteras. The variations north of Cape Hatteras are coherent with those along the eastern boundary.

Variability of the total meridional Sverdrup transport across selected latitude circles is shown to increase northward. The power accounts are less and then the sea level spectra. The transport dependent response of North Atlantic sea level to transport fluctuation is finally discussed.

O32A-07A INVITED

The Estuary As A Filter: An Overview

J. A. SCHUBEL (Marine Sciences Research Center, State University of New York, Stony Brook, N.Y. 11794)
(Sponsor: N. J. Bowen)

I review the processes that characterize the estuary and describe how they cause the estuary to function as a filter for the sediments it receives from the land and from the sea. Tidal currents provide energy for mixing seawater from the ocean with freshwater from the river. The resulting salinity distribution drives the estuarine circulation, which in turn contributes to the salinity distribution. This feedback between salinity-induced circulation and salinity distribution places a constraint (filter) on the range of variation in flow and salt concentration in the estuary. Intertidal estuarine circulation also controls the distribution and transportation of suspended sediment, and the deposition of fine particles within the estuary. The distributions of salt and fine suspended matter control the behavior of many non-conservative constituents: their modes of occurrence, transport, and their rates/sites of accumulation. The result of these processes is that the estuary modifies significantly the strength and the form of the chemical and geological signals it receives. Alteration of an estuary's non-tidal circulation pattern by changing its freshwater input or its geometry produces changes in its filtering efficiency. In general, as an estuary moves from a highly stratified estuary toward a well-mixed estuary, its filtering efficiency for land-derived constituents first increases to a maximum for partially-mixed estuaries and then decreases.

O42A-07A INVITED

Aspects of Storm Induced Sediment Resuspension in Coastal Waters: A Review

W. BRIAN DOWLER (University of Connecticut, Marine Sciences Department, Avery Point, Groton, Ct. 06340)

The passage of high energy storm events has the potential to affect sediment resuspension in coastal and estuarine waters. Resuspension magnitude and associated mass flux varies as a function of local hydrography and sediment characteristics, basin orientation and morphology, and storm quality. This latter factor depends on storm duration, wind speed, intensity, wind direction and the speed and direction of storm advance. Historically studies of this multivariate problem have used a turned parameter approach in which sediment displacements were simply related to storm occurrence without concern for specification of the particular forces dominating mass and effect. This approach provided little information on governing dynamics. Recently improved understanding of two-phase dynamics within the benthic boundary layer and the availability of reliable instrumentation has permitted initiation of field studies of storm resuspension. These studies indicate that storm induced resuspension is typically short-lived and confined to the storm period. This rapid deposition implies settling velocities well in excess of those given by Stoke's law assuming Stoke's settling. Beyond the short-lived nature of storm resuspension the field data indicate a high degree of spatial and temporal variability in controlling factors. In open continental shelf waters resuspension is dominated by surface waves and associated interactions with local tidal currents. Resuspension magnitude is governed primarily by storm duration and intensity and is relatively insensitive to storm track. Proceeding inshore magnitude becomes progressively more sensitive to dominant wind direction as constitus advection effects [illegible] and the intensity of wind/wave induced currents relative to the tidal stream. Associated temporal variability increases due to biologically mediated sediment stabilization and/or destabilization. The field data permit simple modelling of storm resuspension and serve to define areas needing additional research.

Planetology

P12-06A

Transit Time from Mars to Earth

G. W. WETHERILL (DTM, Carnegie Institution of Washington, Washington, D.C., 20015)

Impact experiments and theories suggest that small (< 1m) fragments are those most likely to escape Mars. If SNC meteorites represent such small ejected fragments, their transit time to Earth must be ≤10 m.y., as indicated by the cosmic ray exposure ages. Valid calculations of "Mars-crossing" transit times have been previously presented only for circular Mars-like orbits with perihelion near Mars. These calculated times of 2100 m.y. are not consistent with the observed SNC exposure ages and with the survival of small stony meteorites in the asteroid belt.

Transit times have now been calculated for material ejected at random positions in Mars' orbit at ejection velocities ranging from Mars' escape velocity of 5.1 km/sec up to 5.9 Km/sec. It is found that for velocities greater than 5 + Km/sec from 2 to 4% of the ejecta reach Earth within 12 m.y. This is about 1/3 of the Mars ejecta in this size range that will ever impact Earth.

From these considerations it is permissible to interpret SNC exposure ages as times of ejection from Mars. The principal dynamical problem remains one of overcoming mechanics: acceleration of even small fragments to the required velocities.

(continued on p. 466)

Meetings *(cont. from p. 463)*

P21B-05

Venus Gravity: Ishtar

W. L. SJOGREN (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109)
B. G. Bills and R. J. Hottinger (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109)

Mapping of line-of-sight acceleration data reveal gravity highs that appear to be correlated with the Ishtar highland topography. The largest anomaly of nine milligals at 1200 km altitude is aligned with Maxwell Montes. Data simulations of theoretical gravity were calculated for several profiles under the assumption that the topography was uncompensated in one case and compensated at various depths in other cases. In all cases the geometric effect on the theoretical line-of-sight gravity component produced gravity highs in approximately the same region as the real data mapping. Various model results are compared to the real data profiles and modeling sensitivities to depth of compensation, surface density, and lithospheric flexure are displayed.

SPR-Aeronomy

SA12-18A

Satellite Observations of O⁺ 834 Å Dayglow

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S. Chakrabarti, F. Paresce, S. Bowyer (Space Sciences Laboratory, Univ. of California, Berkeley, CA 94720)

The O⁺ 834 Å dayglow observations made with the EUV spectrometer on the Air Force satellite STP-78-1 are interpreted with the use of a radiation transfer model. At 600 km altitude the dayglow intensity was observed to vary with magnetic latitude from 30 R to 300 R in the near zenith direction (θ = 35°) and from 300 R to 500 R in the near nadir direction (θ = 140°); the correspondingly large near zenith to near nadir intensity ratio of 0.3 - 0.85 over much of the dayside indicates that the O⁺ ions in the topside ionosphere constitute an optically thick medium for resonance scattering of 834 Å airglow emission even at this high altitude. Simultaneous measurements of the O⁺ density from the AE-E spacecraft at 460 km altitude near the equator are used to normalize the STP 78-1 airglow data. A g-value of 1.1 x 10^{-9} s^{-1} is required for the ionization excitation of atomic oxygen leading to the production of O⁺ atoms in ⁴P state. The latitudinal distribution of O⁺ density derived from the 834 Å airglow data shows a double peak (at ±13° lat) surrounding an equatorial trough, characteristic of the equatorial anomaly, at altitudes below 600 km and a single peak at the magnetic equator above 600 km. At high latitudes (> 20°), the O⁺ densities in the summer hemisphere are substantially lower than those in the winter hemisphere.

SA21-01 REVISED ABSTRACT

Ion-Neutral Relative Velocities in the High Latitude F-Region

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S. A. HEELIS
W. B. HANSON (both at: Center for Space Science, University of Texas at Dallas, Richardson, TX 75080)
N. W. SPENCER
L. H. BRACE
L. E. WHARTON (all at: Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, MD 20771)

F-region neutral winds and ion drifts have been measured simultaneously for several high latitude perigee passes of the Dynamics Explorer (DE-2) spacecraft. The neutral wind vector is derived by appropriate merging of the meridional component measured remotely by the Fabry-Perot Interferometer (FPI) with the zonal component measured in situ by the Wind and Temperature Spectrometer (WATS). The ion drift vector is derived from in situ measurements by the Ion Drift Meter (IDM) and the Retarding Potential Analyzer (RPA). These measurements enable the ion/neutral difference velocity to be determined at the satellite altitude along the orbital track. The F-region frictional heating of the ionic and neutral species is evaluated and discussed for the passes studied. In particular, ion temperatures inferred from the measured winds and drifts are compared with direct measurements made with the RPA. In addition, the effect of frictional heating on the compositional structure of the F-region is discussed using data from the Neutral Atmosphere Composition Spectrometer (NACS).

SA51-06A

Simultaneous Observations of Atmospheric Turbulence with 6 and 0.23 meter Wavelength Radars

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O. J. Veltias, (Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701)

The 1290 Mhz (0.23 m wavelength) radar formerly located at Chatanika, Alaska has been operated in a turbulence-scatter mode for measuring winds and turbulence in the upper troposphere and lower stratosphere. Experiments were conducted in conjunction with the Poker Flat MST radar that operates at 50 Mhz (6 m wavelength) and is only 3 kms north of Chatanika.

Data were obtained simultaneously with both radars which had the same range resolution (750 m) and nearly common scattering volumes. The objective of the experiment was to determine differences, if any, in measured turbulence intensity at two scale sizes (11.5 cms and 3 m). For both short and long time averages, we have found enhancements in the level of turbulence measured with the 50 Mhz radar. These differences occurred in the lower stratosphere at 12-13.5 km altitude. Since the antenna elevations were off-vertical the radar echoes have been assumed due to turbulence-scatter only.

In addition, we have found that the maximum heights observable by 1290 and 50 Mhz radars were about 10 and 20 kms respectively. Calculations of turbulence inner scale lengths indicate that both radars should be capable of observing turbulence to much higher altitudes. We conclude that the upper height limits for useful data are determined by the radars' system sensitivities.

SPR-Cosmic Rays

SC11-09a

³⁶Cl IN THE MILK RIVER AQUIFER, ALBERTA: GROUNDWATER DATING AND VERIFICATION OF ION FILTRATION

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D. Elmore and H. Gove, Nuc. Stru. Res. Lab., U. of Rochester, Rochester, NY 14627

The ³⁶Cl groundwater dating method was tested on the Milk River sandstone aquifer, Alberta, because flow in this aquifer is controlled entirely by leakage to overlying and underlying units and was suggested to be very slow. Twenty-four ³⁶Cl analyses of Milk River groundwater were used to determine flow patterns in the aquifer. The isotopically determined flow directions were consistent with those predicted by hydrodynamic data. The ³⁶Cl ages were, however, about five times smaller than the hydrodynamic ages. This discrepancy may be explained by the hydrodynamic influence of glaciers, which covered the study area for about 75% of the Pleistocene and which may have interrupted recharge.

At several sites in the Milk River aquifer, ³⁶Cl concentrations increase down gradient. This decrease is best explained by ion filtration which would be expected to concentrate ³⁵Cl but leave the ³⁶Cl/chloride ratio unaffected. Under the conditions of ion filtration, the ratio would decay with residence time in the aquifer, but the ³⁶Cl concentration would increase. Thus the ³⁶Cl data show that the hydrogeochemistry of the Milk River aquifer is dominated by ion filtration.

SC12-10X

³⁶CL INVESTIGATION OF THE GREAT ARTESIAN BASIN, AUSTRALIA

E. Airey[1], H. Bentley[2], S. Davis[3], P. Phillips[3], and D. Elmore[4]

1. AAEC, Pr. Mail Bag, Sutherland N.S.W. 2232, Aust. 2 U. of Arizona, 3 N. M. Inst. of Mining and Tech., 4 U. of Roch. Nuc. Str. Res. Lab.

As a test of the validity of the use of ³⁶Cl to date very old ground water, a ³⁶Cl investigation was made of the Great Artesian Basin, which covers about about 1.7 X 10⁶ km² in northeastern Australia, about one-fifth of the continent, and is one of the largest artesian aquifer systems in the world. Twenty-four ³⁶Cl/(total chloride) ratios were determined for the Jurassic-Cretaceous "J" aquifer from the recharge area on the eastern flanks of the Great Dividing Range west and southwest to Queensland, in S. Australia. These ratios range from about 110 X 10^{-15} in the recharge area to 1 X 10^{-15} near Lake Eyre. Isochrons developed from the ³⁶Cl data are relatively evenly spaced and indicate ground-water velocities and flow directions consistent with the known hydraulic parameters of the system. The maximum ³⁶Cl ground-water "age" is greater than 1 X 10⁶ yrs. The concordance between the ³⁶Cl ages and those calculated from hydrodynamic data is a strong endorsement of the fundamental assumptions of ³⁶Cl ground-water dating.

SC22-10A

SOLAR CYCLE VARIATION OF THE LATITUDINAL GRADIENT OF SOLAR WIND SPEED AND 5 GeV COSMIC RAYS

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L. A. Fisk, and J. Lockwood, (Dept. of Physics, Univ. of New Hampshire, Durham, NH, 03824

Several recent researches have analyzed the properties of the solar wind as they are organized by the heliospheric current sheet. Synoptic K-coronometer observations allow one to ascertain the position of this current sheet during much of the solar cycle and to explore the properties of the solar wind and the cosmic ray population of the heliosphere with respect to a "heliomagnetic latitude" expressing distance from the current sheet. We have analyzed the latitudinal variation of solar wind speed and 5 GeV Cosmic Ray flux for the years 1964-82.

For all years during which a reliable gradient can be determined, the solar wind speed increases with distance from the current sheet. The gradient varies markedly throughout the solar cycle and attains a sharp maximum at solar minimum. A negative gradient of cosmic ray flux with increasing heliomagnetic latitude is well established during much of the solar cycle. There appears to be no clearly established, systematic variation of this gradient during the cycle.

These cosmic ray profiles will be compared with theoretical models based on the classical diffusion-convection and drift dominated theories of cosmic ray propagation.

* The National Center For Atmospheric Research is sponsored by the National Science Foundation.

Tectonophysics

T21A-09

STRESS AND STRAIN IN CENTRAL NEW HEBRIDES : EFFECTS OF THE SUBDUCTION-COLLISION PROCESS OF THE D'ENTRECASTEAUX ZONE

COLLOT Jean-Yves, ORSTOM Noumea, New Caledonia
DANIEL Jacques, ORSTOM Noumea, New Caledonia
(Sponsor : MAILLET, P.)

A review of the structural evidences and the shallow seismicity, shows that radiant additional horizontal stresses generate a specific compressive stress regime in the Central New Hebrides. Produced deformations show a great resemblance with the theoretical strain field resulting from the indentation of a long narrow rigid plastic body i.e. the arc, by a flat rigid die, i.e. the d'Entrecasteaux zone. Thus, the central New Hebrides block, which is elastically bent under vertical stresses appears to be, further, plastically deformed and pushed eastward under horizontal stresses. Recent uplift of the eastern chain can be explained in this model. The strong plate interaction due to the subduction of the d'Entrecasteaux zone is supposed to be responsible for the compressive stress regime across the central part of the arc.

Examination of the different stress regimes throughout New Hebrides allows to segment the arc into 4 main parts :
- the northern New Hebrides : a tensional zone from the north to the latitude 14°30
- the central New Hebrides : a compressive zone between the latitudes 14°30 and 17°
- the southern New Hebrides : a tensional zone between the latitudes 17° and 20°30
and the southernmost New Hebrides : a mainly compressive zone.

T21B-09 INVITED

A Block Tectonics Model to Explain Seismicity in Southeastern U. S.

P. TALWANI (Geology Department, University of South Carolina, Columbia, S. C. 29208)
S. T. WILLIAMS (same address)

The earliest models suggested that seismicity in southeastern U. S. occurs on NW oriented preexisting zones of weakness, possibly associated with oceanic fracture zones. However, evidence for such onshore features was not recognized. We have examined a variety of data which has enabled us to identify these features, which appear to be associated with observed seismicity. These observations are incorporated in a block tectonics model. We propose two major NW-SE trending blocks, 50-70 km wide and several hundred km long, associated at their SE terminal with oceanic fracture zones. The Blake Spur fracture zone (BSFZ) block can be traced NW through South Carolina to the Brevard zone, where it appears to be offset to NE. It continues as the Eastern Kentucky block, which was recently recognized by Mathews (1982). The Norfolk fracture zone (NFZ) block can be traced through Va., W. Va., and possibly Pa., where it has been termed the Lake Erie-Maryland block by Lavin et al. (1982). Both blocks exhibit evidence of NW and NE movements. The NW movement (~ 40-60 km) is inferred from offsets in aeromagnetic anomalies, and NE movement on BSFZ block is inferred from right lateral offsets (> 40 km) on the Modoc and Brevard faults. The intersection of the BSFZ block with Triassic boundary faults and the Kings Mountain belt in S.C., an unnamed major NE feature in SW Virginia identified by Bollinger and Wheeler (1983), and the Hickman faults zone in Kentucky define the location of seismicity near Summerville, Bowman, and Union County, S.C., Giles County (1897) and Sharpsburg County, Ky. (1980) respectively. The intersection of the NFZ block with a Triassic basin defines the location of seismicity in central Virginia.

T42B-06A

Chemical Potential in Crystals under Non-Hydrostatic Stress

N. B. BAYLY (Geology Department, Rensselaer Polytechnic Institute, Troy, N.Y. 12181) (Sponsor: E. B. Watson)

Gibbs proposed that if a homogeneous crystal of one component is in contact across its orthogonal faces with fluids at three different pressures, it would be necessary, for equilibrium with respect to the tendency of the solid to dissolve, for the chemical potential of that component in the fluids to have three different values. Ever since, there has been speculation about the chemical potential of that component in the solid: the stress state of the solid seems to be the same at all points yet, if the component has a recognizable chemical potential in the solid phase at all, that potential seems to vary from point to point.

A new approach to this old problem suggests the following: 1) Any real phase has a finite viscosity, either zero nor infinite; solids are just phases of higher viscosity than liquids. 2) Any non-hydrostatic stress state is a non-equilibrium state, with energy being continuously dissipated. 3) At a point where the stress state is non-hydrostatic, the chemical potential of a component continues to be definable but is multi-valued; it is a direction-dependent quantity, with three principal values simply linked to the principal stresses. 4) At a point, the difference in chemical potential from-axis-to-axis drives the viscous deformation at that point, in the same way that a potential difference between one point and another drives a diffusive flux.

These suggestions open the way to more satisfactory analyses of simultaneous creep, diffusion and change of phase than have been possible heretofore, and thus may improve our understanding of such textures and deformation.

T42B-60

Evidence for Strain-Rate Controlled Cyclic Feldspar growth in Blastomylonites.

R. J. KNIPE (Dept. Earth Sciences, University of Leeds, Leeds, England, LS2-9JT)
R. P. WINTSCH (Dept. Geology, Indiana University, Bloomington, 47405)

Compositional, textural and microstructural data provide strong evidence for both oscillating strain rates and for cyclic feldspar growth in blastomylonites from the Moine thrust, Scotland and the Insubric line, Switzerland. These processes are related theoretically through chemomechanical feedback mechanisms. Compositional fluctuations in plagioclase porphyroblasts in these mylonites reveal complicated zoning patterns. Discontinuities in the concentrations of CaO, K_2O and FeO mark the boundaries of crescent-shaped overgrowths on opposite sides of ~200 μm diameter cores. Concentration gradients indicate (1) normal plagioclase zoning in both cores and overgrowths and (2) an abrupt increase in μ_{CaO} ($a_{Ca^{++}}/a^2_{H^+}$) at the time of overgrowth. These observations can be explained by a decrease in a_{H^+} caused by ion exchange on surfaces newly exposed during deformation, which also establishes feldspar supersaturation. Textural evidence for high strain rates and grain size reduction comes from < 1 μm muscovite breccias. Evidence for ductile deformation comes from lattice preferred orientations of quartz, and evidence for oscillating strain rates comes from ductile deformation of microbreccia zones. Together the data suggest that cyclic changes of strain rate in fault zones may be related to cyclic periods of crystal growth, which could in turn strongly influence fault rock rheology.

T51-05A

Tapping of magmas from ubiquitous mantle heterogeneities

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Long-lived heterogeneities in the mantle are indicated by Nd-Sr-Pb isotopic systematics. Explanations for these variations have invoked either distinct layers in the earth that are preferentially tapped by some source regions (such as plumes rising from the base of the mantle) or small-scale heterogeneities which are ubiquitously distributed through the mantle. The melting behavior in a region with heterogeneities is modified by lateral conduction of heat. A small (less than a few km), easily melted heterogeneity draws heat from its surroundings as it melts during ascent. An increase of melting by a factor of two over adiabatic ascent is probable in the most easily melted regions. The depleted isotopic ratios of MORB can be explained by selective melting of heterogeneities with some components before others as material ascends beneath the ridge. The first component to melt is identified with the low ¹⁴³Nd/¹⁴⁴Nd, high ⁸⁷Sr/⁸⁶Sr, low ²⁰⁶Pb/²⁰⁴Pb component of Zindler et al. [1982]. The melt from this component enters fractures which carry it upward but outward away from the source region of MORB at the ridge axis. The direction of shear stress in the upwelling is such that the axis of tension plunges away from the ridge axis and dikes of melt dip toward the axis. The remaining material partially melts at shallow levels (where the direction of dike propagation is more nearly vertical) and taps the last-to-melt MORB component, which is more depleted than the average ascending mantle. For this scheme to work, the MORB component must produce a greater volume of melt than the other components. The first component to melt is sometimes tapped by volcanoes away from the ridge axis. At the greater source depths of these volcanoes only this component is significantly molten. An alternative explanation is that the melt which moved laterally, rather than to the surface, at the ridge axis is tapped by the off-axis volcanoes. A third component with high ²⁰⁸Pb/²⁰⁴Pb has intermediate melting characteristics between the other two components and is tapped to some extent on and off axis.

Volcanology, Geochemistry, and Petrology

V21A-15A

TITANIUM : HYGROMAGMAPHILE AND/OR NON HYGROMAGMAPHILE ELEMENT.

N EL AZZOUZI (UNEXO-IOB, B.P. 337, 29273 Brest Cedex, France) ; B. BOUGAULT and G. MAURY (U.B.O. Fac. Galonte, 6 av. Le Gorgeu, 29283 Brest Cedex, France) ; B. VILLEMAN, J.L. JORON and M. TREUIL (Lab. Geochemistry 1 24-25, E3, Univ. P.M. Curie, 4 place Jussieu, 75230 Paris Cedex 05, France).

The hygromagmaphile character of titanium during the genesis of Mid-Ocean Ridge Basalts (MORB) is well established. A large number of tholeiites sampled in different parts of the oceans has been considered for Ti but also for other hygromagmaphile elements - Rare Earths and other transition elements whose ions have a rare gas electronic structure -. This study shows that Ti behaves very similarly to Zr, Hf and Ta. This property is explained both by incompatibility to enter into a crystal structure and the availability to form complexes in the liquid. It is thus possible to incorporate Ti in a Coryell-Masuda diagram, provided that Ti position on a axis is chosen close to Ta. Negative anomalies of Ti are observed in such a diagram when oxygen fugacity allows Ti rich minerals to precipitate. An excellent example is shown by samples of an alkali series of "Chaine des Puys" from Massif Central in France. Ti removal can be estimated from the theoretical normalized concentrations obtained from Zr, Hf or Ta, that Ti should have if no removal had occurred.

Three statements can be deduced from the incorporation of Ti in an extended Coryell-Masuda plot :
- the absolute concentration of Ti (no more than Ta concentration) is not a parameter in itself to make differences either between alkali or tholeiitic basalts or between enriched or depleted basalts ;
- a Zr/Ti ratio is not a good discriminant since equivalent to a ratio of two neighbour middle Rare Earths that can only fractionate in a small extent ;
- negative Ti anomalies make possible to identify opaque precipitation and to evaluate Ti removal during magmatic differentiation.

V42A-09

Structures of Glasses Along the Join SiO_2-GeO_2

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In order to better understand the distribution of SiO_4 and AlO_4 tetrahedra in three-dimensional network structures of Aluminosilicate melts and glasses, we have investigated the structure of binary SiO_2-GeO_2 glasses using Raman spectroscopy. It has been found that the mixing of GeO_2 and SiO_2 melts results in a continuous random network structure of TO_4 tetrahedra (T = Si, Ge) in the glass. In the spectrum of $50SiO_2$·$50GeO_2$ glass the bands corresponding to antisymmetric stretching (v_{as}) of oxygen in Ge-O-Ge, Si-O-Si and Si-O-Ge bonds are observed near 880, 990 and 1095 cm^{-1}. The presence of these three v_{as}(T-O-T) bands in the spectrum of a glass having Si/Ge of one reveals thus a considerable degree of Si-Ge disorder in the glass. The presence of a single v_s(T-O-T) band in the spectra of binary SiO_2-GeO_2 glasses indicates that the v_s(Si-O-Si), v_s(Si-O-Ge) and v_s(Ge-O-Ge) modes are strongly coupled. The observed decrease in the halfwidth of the v_s(T-O-T) band of SiO_2-GeO_2 glasses with increasing concentration of GeO_2 has been attributed to a decrease in the average T-O-T bond angle in the GeO_2-rich glasses. The results of the present study provide further confirmation of the assignment of the bands in the 900-1200 cm^{-1} region of aluminosilicate glass spectra to v_{as}(Al-O-Si) and v_{as}(Si-O-Si) modes (1). In contrast to aluminosilicate glasses, however, the SiO_2-GeO_2 glasses have a much higher degree of disorder of network-forming cations. It seems that the aluminum avoidance rule tends to stabilize the Al-Si disorder in aluminosilicate melts and glasses.

(1) AOS 63, 469 (1982).

V41B-12A

The Distribution of Alkali Cations in High-Silica M_2O-SiO_2 Glasses

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To gain an insight into the effect of alkali type on the distribution of alkali cations in silica-rich igneous silicate melts, a systematic Raman spectroscopic investigation of high-silica M_2O-SiO_2 glasses (M = Li, Na, K, Rb, Cs) has been performed. It is shown that distinct regions of the glass spectra can be used to infer regional and localized (i.e., Q-species) alkali distribution. High frequency bands at ~1100 cm^{-1} and ~950 cm^{-1} result from highly localized Si-nonbridging oxygen stretching modes of the Q_3 and Q_2 species, respectively, where the subscripts refer to the number of bridging oxygens per SiO_4 tetrahedron. The Q_2 species is found to favor the Q_3 species in all glasses investigated, but Q_2 decreases rapidly with increasing alkali size. A 440 cm^{-1} band characteristic of the silica glass spectrum results from a delocalized vibrational mode [v_s(Si-O-Si)] and its presence in an alkali-silica glass spectrum indicates that regions of ordered silica-like structure exist in that glass. The 440 cm^{-1} band intensity is found to decrease more rapidly with alkali content in the spectra of Cs, Rb, and K silicate glasses, and to persist to higher alkali contents in the spectra of Li and Na glasses. The smaller alkali cations are therefore shown to have a strong tendency toward regional clustering in silica glasses similar to that producing phase separation even at temperatures well above the metastable immiscibility regions of these systems. While regional alkali distribution is strongly dependent on the history of the glass, the Q-species distribution appears to be dependent only on the glass composition.

V51B-12A

The Heat Capacity and Phase Equilibria of Monticellite

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The heat capacity of a natural monticellite ($Ca_{1.00}Fe_{0.13}Mg_{0.86}Si_{1.00}O_{4.00}$) has been measured from 5-350 K using intermittent heating calorimetry. These measurements yield Cp_{298} = 123.2 joules/mol and S_{298} = 111 joules/mol-K, 1-4% different than previously published estimates. High temperature entropy data were measured using a differential scanning calorimeter to 1000 K. These data were smoothed using the 290-350° values, and yield Cp (joules/gm-K) = ... The Gibbs free energies of formation ... were calculated from the reactions Wollastonite + Monticellite = Forsterite + Merwinite and Diopside + Monticellite = Forsterite + Akermanite, in good agreement with estimates from Walter (1963) and Helgeson et al. (1978). These reactions and those in the system Merwinite - Akermanite - Forsterite - Monticellite were recalculated using the new data and the monticellite data. The new data support previous work by Yalley and Essene (1980). The calculated curves match the experimental reversals of Yoder (1968, 1975) and Yoder (1964) for all reactions except Diopside + Merwinite = Akermanite and Merwinite + Forsterite = Monticellite, where a significant difference exists between the calculated and experimental slopes of the reactions. The inability to match these reactions, as noted by Valley and Essene (1980), suggests an error of the order of -15 joules/mol-K for the entropy of merwinite. Low temperature calorimetry of merwinite is necessary to evaluate the source of this error.

V51S-12B

Thermodynamics and phase equilibria of clinochlore [$(Mg_5Al)(Si_3Al)O_{10}(OH)_8$]

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The heat capacity of a natural chromian clinochlore ($Mg_{4.7}Fe_{0.3}Al_{...}Cr_{...}$) (Chl), measured from 4 to 300 K in an adiabatic calorimeter yielded S_{298} = 404.8 J/mol K. Further measurements in a differential scanning calorimeter yield Cp = 17.0557 - 1.4184·10^{-4}T + 6.5142·10^{-7}T² ... + 1.4955·10^{-5}T^{-2} (J/gm). When this function is integrated and corrected for Cr, Fe and other solid solutions, it yields S^o_{298} = 397.8 J/mol K for pure clinochlore with a zero point contribution, 416.4 J/mol K for clinochlore with a short range contribution and 435.0 J/mol K for fully disordered clinochlore. Least squares refinement of X-ray powder data for clinochlore yield V_{298} = 207.35 cc/mol when corrected for the observed solid solution. Calculations of phase equilibria in the system MgO-Al_2O_3-SiO_2-H_2O using these entropy and volume data generally fit the reversed experiments of Fawcett and Yoder (1966), Chernosky (1974), Staudigel and Schreyer (1977), and Jenkins (1981) for the reactions Chl = En + Fo + Sp + V and Chl = Fo + Crd + Sp + V at pressures below 5 kbars. Combination of entropy data with available experiments on its stability yields $\Delta G^o_{f,298}$ = -8164 ± 10 kJ/mol assuming ordered clinochlore and -8175 ± 10 kJ/mol assuming disordered clinochlore. Phase equilibria of clinochlore are calculated in the system K_2O-MgO-Al_2O_3-SiO_2-H_2O with these data. Determination of the equilibrium degree of short- and long-range order in phases such as this is necessary before the uncertainties in phase equilibria may be resolved.

Geophysical Year

New Listings

The complete Geophysical Year last appeared in the May 31, 1983, *Eos*.

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

Aug. 8–13, 1983 Ninth International Association of Planetology International Symposium, Second IAP General Assembly, and Second International Planetological Conference, Brussels, Belgium. (Rene J. Dejaiffe, Royal Observatory of Belgium, Avenue Circulaire 3, B1180 Brussels, Belgium; telephone: 2-375-2484.)

Aug. 10–16, 1983 1983 Field Workshop on a Cross-Section of Archean Crust, Northeastern Ontario, Canada. (Pam Jones, Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058; telephone: 713-486-2150.)

Aug. 11–16, 1983 Second International Symposium on River Sedimentation, Nanjing, China. Sponsors, UNESCO and United Nations Development Program. (Dou Guoren, Executive Secretary, The Second International Symposium on River Sedimentation, Nanjing Hydraulic Research Institute, 223 Guangzhou Road, Nanjing, 210024, People's Republic of China; telephone: 33662, cable 5710.)

Aug. 14–18, 1983 Conference on Glass in Planetary and Geological Phenomena, Alfred, N.Y. (L.D. Pye, New York State College of Ceramics, Alfred University, Alfred, NY 14802; telephone 607-871-2432.)

Aug. 15–27, 1983 Joint Meeting UNESCO/International Commission of Snow and Ice, Hamburg, Germany. (Sorin Dumitrescu, Director, Division of Water Sciences, UNESCO, 7, place de Fontenoy, 75700 Paris, France; telephone: 331-577-1610 x6093.)

Aug. 29–Sept. 7, 1983 International Symposium on Groundwater in Water Resources Planning and International Workshop on Groundwater in Rural Water Supply, Koblenz, Germany. Sponsors, International Hydrological Program and Operational Hydrology Programme. (K. Hofius, Secretary IHP/OHP, Postfach 309, D-5400 Koblenz, FRG.)

Sept. 1, 1983 International Workshop on the Application of Groundwater Protection and Rehabilitation Methods, Koblenz, Germany. Sponsor, International Hydrological Program. (Sorin Dumitrescu, Director, Division of Water Sciences, UNESCO, 7, place de Fontenoy, 75700 Paris, France; telephone: 331-577-1610 x6093.)

Sept. 3–4, 1983 Workshop on Past and Present Solar Radiation: The Record in Meteoritic and Lunar Regolith, Mainz, Germany. (Pamela Jones, Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058; telephone: 713-486-2150.)

Sept. 5–9, 1983 46th Annual Meteoritical Society Meeting, Mainz, Germany. (Friedrich Begemann, MPI für Chemie, Postfach 3060, D-6500 Mainz FRG.)

Sept. 11–14, 1983 Distribution System Symposium, Birmingham, Ala. Sponsor, American Water Works Association. (AWWA, 6666 West Quincy Ave., Denver, CO 80235; telephone: 303-794-7711.)

Sept. 12–16, 1983 International Water Supply Association Exhibition and Conferences, Brussels, Belgium. (IWSA Secretariat, 1 Queen Anne's Gate, London SW1 9BT, United Kingdom.)

Oct.–Nov. 1983 22nd Session of the UNESCO General Conference. (Sorin Dumitrescu, Director, Division of Water Sciences, UNESCO, 7, place de Fontenoy, 75700 Paris, France; telephone 331-577-1610 x6093.)

Oct. 9–12, 1983 Meeting: Association of Earth Science Editors, Houston, Tex. (Pamela Jones, Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058; telephone: 713-486-2150.)

Oct. 9–13, 1983 Nineteenth Annual AWRA Conference and Symposium, San Antonio, Tex. Sponsor, American Water Resources Association. (Kenneth D. Reid, Executive Director, AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814.)

Oct. 9–15, 1983 Sixth International Symposium on Environmental Biogeochemistry, Santa Fe, N.M. (James A. Brierley, Department of Biology, New Mexico Institute of Mining and Technology, Socorro, NM 87801.)

Oct. 17–20, 1983 American Astronomical Society Division of Planetary Sciences 15th Annual Meeting, Ithaca, N.Y. (Stephen J. Ostro, Space Sciences Building, Cornell University, Ithaca, NY 14853.)

Oct. 18–20, 1983 Fifth Conference on Hydrometeorology, Tulsa, Okla. (W.L. Pugsley, Program CoChairman, Chief Hydrometeorology Division, Canadian Climate Centre, 4905 Dufferin St., Downsview, Ont. M3H 5T4 Canada; telephone: 416 667-4617.)

Oct. 18–20, 1983 Tri-Services Infrared Backgrounds Symposium, Burlington, Mass. Sponsor, Department of Defense. (R.E. Murphy, AFGL/OPR, Hanscom AFB, MA 01731.)

Dec. 5–9, 1983 International Conference: Groundwater and Man, Sydney, Australia. (The Services Pty Ltd., P.O. Box 1029, Canberra City, ACT 2601, Australia; telephone: 062–49–8015; telex: AA62260 (UNIHS-ACTS).)

Dec. 5–9, 1983 Symposium on Optimization Techniques for Managing Groundwater and Stream-Aquifer Systems, San Francisco, Calif. Sponsor, AGU Groundwater Committee. (Steven G. Gorelick, U.S. Geological Survey, Mail Stop 21, 345 Middlefield Rd., Menlo Park, CA 94025; telephone: 415-323-8111 x2141 or Manoutch Heidari, Kansas Geological Survey, Lawrence, Kans.; telephone: 913-864-5672.)

Dec. 15–17, 1983 Second Annual Meeting of the Working Group on Mediterranean Ophiolites, Florence, Italy. (Giovanni B. Piccardo, Instituto di Mineralogia, Petrographia e Geochimica-Università, via La Pira 4, 50121 Firenze, Italy.)

March 19–23, 1984 Fifth Northern Research Basins Symposium and Workshop, Vierumaki, Finland. (Olli Faasanen, Secretary, Organizing Committee, Hydrological Office, Box 436, 00101 Helsinki 10, Finland.)

March 19–27, 1984 Sixth Session of the International Hydrological Program

April 1984 CSCE/ASCE Cold Regions Engineering Specialty Conference on Northern Resource Development, Edmonton, Alberta, Canada. (Daniel W. Smith, Dept. of Civil Engineering, University of Alberta, Edmonton, Alberta, T6G 2G7, Canada.)

April 1984 Arctic Water Pollution Research: Applications of Science and Technology, Yellowknife, N.W.T., Canada. (W.A. Bridgeo, Bridco Values, Ltd., P.O. Box 3161, Halifax South Post Office, Nova Scotia, B3J 3H5, Canada.)

April 3–5, 1984 Interdisciplinary Conference on Meeting the Water Needs of the Southwest, Dallas, Tex. (Michael A. Collins, School of Engineering and Applied Science, Southern Methodist University, Dallas, TX 75275; telephone: 214-692-3060.)

May-June 1984 12th International Congress on Irrigation and Drainage, Fort Collins, Colo. (ICID, 48 Nyaya Marg, Chanakyapuri, New Delhi 110012, India.)

June 11–13, 1984 Symposium on Critical Assessment of Forecasting in Western Water Resource Management, Seattle, Wash. Sponsor, American Water Resources Association. (Gary R. Minton, President, Resource Planning Associates, 113 Lynn Street, Seattle, WA 98109; telephone: 206-282-1681.)

June 24, 1984 International Symposium on Impermeable Barriers for Soil and Rock, Denver, Colo. (A. Ivan Johnson, Woodward-Clyde Consultants, 7600 E. Orchard Road, Englewood, CO 80111; telephone: 303-694-2770.)

June 24, 1984 International Conference on Geomembranes, Denver, Colo. (A. Ivan Johnson, Woodward-Clyde Consultants, 7600 E. Orchard Road, Englewood, CO 80111; telephone: 303-694-2770.)

June 25–July 7, 1984 Symposium on Space Observations for Climate Studies, Graz, Austria. Sponsor, World Climate Program. (S. Ruttenberg, Secretary, COSPAR Commission A, NCAR, Boulder, CO 80307.)

Chapman Conference on Natural Variations in Carbon Dioxide and the Carbon Cycle

Call for Papers

A Chapman Conference on "Natural Variations in Carbon Dioxide and the Carbon Cycle" will be held in Tarpon Springs, Fla., January 9–13, 1984. The purpose of the conference is to gather geologists who are studying various aspects of carbon cycle history together with geochemical modelers and with biologists, oceanographers, and meteorologists who are familiar with present and potential future relationships among the carbon cycle, atmospheric CO_2, and climate.

The potential climatic effects of anthropogenic CO_2 have stimulated a worldwide program of interdisciplinary carbon cycle research. At the same time, geologists have intensified their studies of such global processes as carbonate dissolution, organic carbon burial, sea level change, and other mechanisms that may have caused or reflected carbon cycle changes in the past. These largely independent trends in environmental and geological research are fundamentally related. The geological record shows a significant degree of carbon cycle variability before any human influence, suggesting the possibility of past atmospheric CO_2 fluctuations. What caused the carbon cycle variations? How were they related to atmospheric CO_2? Were they associated with climate changes consistent with the CO_2/climate predictive models? To what extent could natural variations contribute to the present CO_2 budget? What are the long-term geochemical implications of fossil fuel CO_2? These are among the questions that will be discussed at this conference.

The conference will consist of both invited and contributed papers. It is expected that about two-thirds of the participants will be geologists and about one-third will be from the CO_2 research community. One or two meeting sessions will be devoted to overview talks by experts on the application of ocean modeling, climate modeling, and biosphere modeling to CO_2 research. The remainder of the conference will emphasize the geological record. Because studies covering different time scales are often concerned with different kinds of processes and data, the meeting will be organized around six "time slices": (1) the last 2,000 years, (2) the last 20,000 years, (3) the last 2 million years, (4) the Cenozoic, (5) the Phanerozoic, and (6) the Precambrian. These categories are not meant to be rigidly restrictive; for example, the third category might include Pliocene hydraulic piston core data, and the fourth might include the Cretaceous/Tertiary boundary.

The 5-day conference will include morning and evening sessions, with afternoons devoted to informal discussions and recreation. In order to encourage interdisciplinary discussion, there will be no parallel sessions, and oral presentations will be allotted at least 30 minutes each. If necessary, space and time will be available for poster sessions. All of the oral presentations, and perhaps some of the poster presentations and summaries of discussions, will be published by AGU in a Geophysical Monograph within one year of the conference.

Arrangements are being made for grants to cover travel and conference costs for a number of attendees, including several students. Students wishing to apply should write to AGU by September 15, 1983, giving educational background, reasons for wanting to attend the conference, and current interests. Awardees will be selected by AGU in conjunction with the program committee. All who are interested in attending and in receiving later information circulars should write to Carbon Cycle Meeting, AGU, 2000 Florida Avenue, N.W., Washington, D.C. 20009 (telephone toll free: 800-424-2488 or, in the D.C. area, 462-6903).

To submit an abstract, follow the abstract format published in *Eos*, June 28, 1983. There will be no abstract charge. All abstracts should be sent to E. T. Sundquist, U.S. Geological Survey, 431 National Center, Reston, VA 22092.

Abstract Deadline: September 15, 1983

Program Committee: E. T. Sundquist (co-convenor), U.S. Geological Survey; W. S. Broecker (co-convenor), Lamont-Doherty Geological Observatory; R. Bacastow, Scripps Institution of Oceanography; E. J. Barron, National Center for Atmospheric Research; W. H. Berger, Scripps Institution of Oceanography; T. C. Moore, Jr., Exxon Production Research Company; H. Oeschger, Physikalisches Institut, Universität Bern; S. H. Schneider, National Center for Atmospheric Research.

GAP

Aeronomy

0310 Aeronomy (Composition, Atoms and Molecules)

ENHANCEMENT OF HEAVY OZONE IN THE EARTH'S ATMOSPHERE

Jack A. Kaye (Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375) and Darrell F. Strobel

The possible enhancement of isotopically heavy ozone ($^{50}O_3$) in the earth's stratosphere and mesosphere produced by the preferential photodissociation of heavy oxygen ($^{34}O_2$) is considered. On the basis of a realistic oxygen-only model, we show that the rapidity of the exchange reaction

$$^{18}O + {}^{32}O_2 \rightleftarrows {}^{16}O + {}^{34}O_2$$

prevents any enhancement at stratospheric temperatures. Since in situ mass spectrometric observations suggest that such an enhancement exists, one is left with a paradox. Possible modifications to the chemical model, which include isotopically specific photochemistry of ozone, are shown to be noncompetitive with the exchange reaction (ozone, stratosphere, isotope enrichment).
J. Geophys. Res., Green, Paper 3C0912

Electromagnetics

0720 Electromagnetic theory

ULF/ELF ELECTROMAGNETIC FIELDS PRODUCED IN A CONDUCTING MEDIUM OF INFINITE EXTENT BY LINEAR CURRENT SOURCES OF INFINITE LENGTH

A.S. Inan (STAR Laboratory, Stanford University, Stanford, California, 94305), A.C. Fraser-Smith, and O.G. Villard, Jr.

A previous analysis of a linear current source of finite length embedded in a conducting medium of infinite extent is extended to linear current sources of (i) infinite length and (ii) semi-infinite length. Electric and magnetic field expressions are derived and the results are numerically evaluated for frequencies in the ULF/ELF bands. For convenience, some of the results are presented in a dimensionless form. A comparison is made between the electromagnetic fields produced by linear current sources of finite and infinite length and it is shown that there is a relative enhancement in the electric field near the source of finite length. It is also found that an optimum frequency exists for the electric field produced by linear current source of finite length at which the field amplitude is a maximum at a fixed observation point. Some practical applications of our results are suggested.
Rad. Sci., Paper 3S1053

0736 Media Effects

CALCULATION OF ICE DEPOLARIZATION ON SATELLITE RADIO PATHS

A. Tsolakis and W. L. Stutzman (Virginia Tech, Electrical Engineering Department, Blacksburg, VA 24061)

In this paper theoretical methods are presented for calculating the depolarization of ice clouds. Rayleigh scattering from single particles is used. A general theory is introduced that includes distributions of ion particle shapes and orientation region for both single and multiple scattering. It is shown that the more accurate multiple scattering formulation yields XPD values significantly worse than that for single scattering over the 10 to 30 GHz band for high ice content. Comparisons are made to measurements using the SIRIO satellite.
Rad. Sci., Paper 3S0968

0736 Media Effects

THE IMPACT OF ICE ALONG SATELLITE TO EARTH PATHS ON 11 GHz DEPOLARIZATION STATISTICS

W. L. Stutzman (Virginia Tech, Electrical Engineering Department, Blacksburg, VA 24061)
C. W. Bostian, A. Tsolakis, and T. Pratt

This paper summarizes measurements of ice depolarization made using a unique facility consisting of a dual site (7.2 km site spacing), dual circularly polarized, low elevation angle (10.7°) receiving system for the SIRIO 11.6 GHz beacon. In several cases nearly simultaneous disturbances were observed on both sites, indicating large ice clouds were present. Significant depolarization (XPD as low as 10 dB) in the absence of attenuation occurred relatively frequently. However, the impact of the ice on the XPD statistics for a six month time period was small.
Rad. Sci., Paper 3S0981

0773 Remote Sensing

RADIOMETRIC SENSING OF BIOLOGICAL LAYERED MEDIA

F. Bardati, D. Solimini (Dipartimento di Ingegneria Elettronica, Università di Roma-Tor Vergata, 00173 Roma, Italy)

The retrieval of temperature profiles in layered living tissues from microwave radiometric measurements is considered. The brightness temperature of a layered biological structure is expressed as a function of the thermal distribution in the tissues for different microwave frequencies, angles of observation and polarization of the emitted waves. A coherent approach to the radiative transfer problem is followed to obtain the weighting functions in closed form for use in the inverse problem. The extraction of the thermal profiles from brightness data sets by use of Kalman filtering is finally discussed, with particular reference to the detectability of deep thermal anomalies. (Thermal emission, microwave radiometry, bioelectromagnetism).
Rad. Sci., Paper 3S1001

Geochemistry

1419 Chemistry of the Atmosphere

TEMPORAL DISTRIBUTIONS OF RADIOSTRONTIUM ISOTOPES AND RADON DAUGHTERS IN RAINWATER DURING A THUNDERSTORM

L. A. Burchfield, J. O. Akridge and P. K. Kuroda (Department of Chemistry, University of Arkansas, Fayetteville, Arkansas 72701)

The concentrations of ⁸⁹Sr, ⁹⁰Sr, ¹³⁷Cs, ²¹⁰Pb, ²¹⁴Pb, and ²¹⁰Po were measured in sequentially sampled rainwater during a thunderstorm which occurred at Fayetteville, Arkansas, on 29 January 1981. Approximately concordant mean residence times ranging from 43 to 136 days were obtained from the observed ratios of ⁸⁹Sr/⁹⁰Sr and ²¹⁰Po/²¹⁰Pb. The ²¹⁰Pb/²¹⁴Pb ratio was found to correlate negatively with the ²¹⁰Po/²¹⁰Pb ratio. The variation of the ²¹⁰Pb/²¹⁴Pb ratio appeared to have resulted from turbulent mixing of air masses and increased sharply after the time the rainfall reached a peak value.
J. Geophys. Res., Green, Paper 3C0667

Hydrology

3110 (Erosion and Sedimentation)

CAUSES OF RIVER-BED DEGRADATION

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River-bed degradation can proceed downstream as well as upstream depending upon the cause of degradation. The causes of downstream progressing degradation are primarily related to changes to independent river channel variables, such as increase in water discharge, decrease in size of bed-material, and decrease in bed-material discharge. The causes of upstream progressing degradation are all related to an imposed increase in river slope which can occur as a result of natural river behavior or by man-made changes. Study of various case histories indicates that river slopes are increased by lowering a base level, by decreasing the length of a river or by removal of a control point. Case histories also show that downstream and upstream progressing degradation can act in combination along a river system; downstream progressing degradation along the main stream of a river system can initiate upstream progressing degradation on a tributary.
Water Resour. Res., Paper 3W0908

3180 Water Quality

SAMPLING FREQUENCY FOR WATER QUALITY MONITORING

D. Casey (Faculty of Commerce, University of British Columbia, Vancouver, B.C., Canada V6T 1W5), P.N. Nemetz and D.H. Uyeno

Selecting the sampling frequency is one of the most important tasks in the design of a regulatory water quality monitoring program. This paper proposes two quantitative measures of the effectiveness of different sampling frequencies; these measures are intended to be used as the preliminary program design stage. The goal of the program is assumed to be the detection of violations of water quality standards. The first measure, N', gives the expected proportion of violations that will be detected. The second, N", is the ratio of the expected number of violations. Mathematical expressions for both statistics are developed. It is shown that by making the average sampling interval equal to the average duration of a violation, the expected number of violated samples would equal the expected number of violations since the errors caused by missing some violations and counting others more than once would tend to cancel out. (Water quality, monitoring, sampling).
Water Resour. Res., Paper 3W0040

Meteorology

3710 Boundary layer structures and processes
USE OF LONG-LIVED RADON DAUGHTERS AS INDICATORS OF EXCHANGE BETWEEN THE FREE TROPOSPHERE AND THE MARINE BOUNDARY LAYER
Mark S. Brits (Atmospheric Experiments Branch, NASA Ames Research Center, Moffett Field, CA 94035)
Fluxes and exchange coefficients are derived for the transport of ^{90}Sr, ^{210}Pb, ^{210}Bi and ^{210}Po between the free troposphere and the marine boundary layer, and between the boundary layer and the sea surface. Radionuclide concentrations previously measured near Hawaii are used in the derivations. Values obtained for the free troposphere/boundary layer exchange coefficient (expressed as a piston velocity) were 189, 228 and 203 m d^{-1} for ^{210}Pb, ^{210}Bi, and ^{90}Sr, respectively. The magnitude of the local sea-surface source of ^{210}Po is also derived. (Atmospheric radionuclides, marine atmosphere, free troposphere/boundary layer exchange).
J. Geophys. Res., Green, Paper 3C1027

3715 Chemical composition and chemical interactions
THE CONCENTRATION OF AMMONIA IN SOUTHERN OCEAN AIR
G.P. Ayers (Division of Atmospheric Research, CSIRO, P.O. Box 77, Mordialloc, Victoria, 3195, Australia.) and J.L. Gras
Measurements of ammonia gas concentration at Cape Grim (40°41'S., 144°41'E.) have been made during six field expeditions between February 1978 and May 1980. For this coastal site a clear distinction between maritime and continental winds was evident in the observed ammonia concentrations. While continental winds gave concentrations comparable with those generally reported in the northern hemisphere (~1 µg m^{-3}, STP), maritime winds gave much lower concentrations (mean 0.06 µg m^{-3} STP). No large seasonal trend was apparent in the latter data.
J. Geophys. Res., Green, Paper 3C0815

3715 Chemical Composition and Chemical Interactions
RURAL MEASUREMENTS OF THE CHEMICAL COMPOSITION OF AIRBORNE PARTICLES IN THE EASTERN U.S.
G. T. Wolff (Environmental Science Department, General Motors Research Laboratories, Warren, Michigan, 48090), S. A. Kelly, B. A. Forman, and Mark L. Morrissey
Quantitative measurements of particulate composition were made at three rural sites: in central South Dakota, on the Louisiana Gulf Coast and in the Blue Ridge Mountains of Virginia. The first two sites were selected to determine background concentrations in continental polar and maritime tropical air masses, respectively, which affect the eastern U.S. during the summer. The Virginia site was selected as a receptor site, downwind of the midwestern source areas. The South Dakota data established the background concentrations. These concentrations were similar to the levels in Louisiana when air parcels arrived from the Gulf of Mexico without recently passing over the U.S. Levels of fine particles (diameters less than 2.5 µm) were highest in Virginia and were due chiefly to sulfate. Using trajectory and statistical analyses, it is shown that the residence time of an air parcel over the midwestern source area was the most important variable in determining the sulfate levels in the Blue Ridge Mountains.
J. Geophys. Res., Green, Paper 3C0865

3715 Chemical composition and chemical interactions
AN INVESTIGATION OF SULFATE PRODUCTION IN CLOUDS USING A FLOW-THROUGH CHEMICAL REACTOR MODEL APPROACH
Min-Sun Hong and Gregory R. Carmichael (Chemical and Materials Engineering, University of Iowa, Iowa City, Iowa 52242).
A flow-through chemical reactor model is developed to describe the mass transfer and chemical processes that atmospheric gases undergo in clouds. The model includes the simultaneous absorption of SO_2, NH_3, O_3, NO_x, HNO_3, CO_2 and H_2O_2, the accompanying dissociation and oxidation reactions in cloud water, considers solution electro-neutrality, and includes qualitative parameterization of cloud microphysics. The model is used to assess the importance of the oxidation reaction H_2O_2-S(IV), O_3-S(IV) and S(IV)-Mn^{++} catalysis, and the affects of cloud parameters such as drop size, rain intensity, liquid water content and updraft velocity. Both precipitating and non-precipitating clouds are studied.
Model results predict sulfate production rates varying from 1%/hr to 230%/hr (expressed in terms of gaseous SO_2 conversion rate). The actual rate is highly dependent on the chemical composition of the uptake air and the physical conditions of the cloud. Model results also show that both the H_2O_2 and the O_3 oxidation reactions can be significant.
J. Geophys. Res., Green, Paper 3C0977

3720 Climatology
SURFACE ALBEDO DATA FOR CLIMATIC MODELLING
A. Henderson-Sellers (Department of Geography, University of Liverpool, P.O. Box 147, Liverpool, U.K.), M. F. Wilson
The climate system is driven, primarily, by energy absorbed at the surface. Surface albedo sensitivity is incorporated into all types of climate models and changes can lead to large feedback effects. For example, alterations in the extent and/or state of the cryosphere and large-scale modification of vegetation cause significant perturbations in climate model results. The specification of surface albedo in general circulation climate models (GCMs) differs. An improved and agreed surface albedo data set is urgently required for climate modelling. It is likely that the most appropriate means of achieving consistent and credible surface albedos is by using well-designed satellite surveillance to augment global inventories of soils and vegetation. However, retrieval of surface albedo values for all sky and surface conditions from satellite observations is difficult. Atmospheric distortion is especially hard to remove. Some of the sensitivity of GCMs to surface albedo values may be the result of inadequate parameterization of other climatic components. The accuracy of information demanded by climate modelers could be reduced and made more consistent. Recommendations are made for the implementation of a new global-scale observational programme with the aim of providing surface albedo data with an accuracy of ± 0.05 within 5-10 years. Immediate initiation is urged. (Climate models, satellite surveys, surface albedo).
Rev. Geophys. Space Phys., Paper 3S1885

3735 Electrical phenomena (lightning)
POSITIVE CLOUD-TO-GROUND LIGHTNING RETURN STROKES
M.A. Beasley (Department of Electrical Engineering, University of Florida, Gainesville, FL 32611), M.A. Uman, D.M. Jordan and C. Ganesh
Several recent papers have reported positive cloud-to-ground lightning, but, in our opinion, none provides sufficiently direct evidence that positive return strokes occurred in any given case. Here we present observations that plainly demonstrate the occurrence of positive return strokes in a convective thunderstorm in Florida in August, 1981. These observations consist of waveforms of electric field correlated in time with light pulses received through a narrow collimated slit aimed about 1.5 degrees above a level plane and with videotape records of lightning channels. We studied lightning during one 75-minute interval at a range of 80 to 40 km. During this period we recorded time-correlated waveforms from three positive return strokes. The 10%-90% rise times of the electric fields, 1-5 µs, and of the light pulses, 3-8 µs, were similar to those of negative return strokes in the same storm. The light signals of the positive return strokes began 2 to 8 µs after the electric fields, consistent with return-stroke speeds of about 10^8 ms^{-1}, a value comparable to speeds of ordinary negative return strokes. (Lightning, Positive Return Strokes, Positive Ground Flashes)
J. Geophys. Res., Green, Paper 3C0813

3735 Electrical Phenomena (Thunderstorm Electrification)
TRANSIENT WORKMAN-REYNOLDS FREEZING POTENTIALS
J.N. Caranti and A.J. Illingworth (Dept. of Physics, UMIST, Manchester M60 1QD, UK)
Workman-Reynolds freezing potentials may result in thunderstorm electrification or aircraft precipitation static. Laboratory experiments on the development of these freezing potentials when both supercooled solution freezes, and when raindrops and cloud droplets freeze on impact with an ice surface, show that:
a) Any potentials developed are very much smaller than the published values for the quasi-static case.
b) In situations of atmospheric importance the drops will be supercooled, and such solutions are very much less efficient in developing potentials than non-supercooled ones.
c) Cloud droplets freeze very rapidly and if any freezing potential develops during this time then it decays in less than 3msec and is statistically unlikely to affect charge transfer in subsequent collisions with ice crystals.
We conclude that in the atmosphere Workman-Reynolds potentials do not influence the charge transferred by colliding precipitation particles and briefly consider other relevant mechanisms. (Thunderstorm electrification, charging, precipitation static).
J. Geophys. Res., Green, Paper 3C0940

3740 General Circulation
LARGE-SCALE ATMOSPHERIC MIXING DERIVED FROM MERIDIONAL PROFILES OF Kr-85
W. Weiss, A. Sittkus, H. Stockburger, H. Sartorius (Max-Planck-Institut für Kernphysik, Außenstelle Freiburg-Schauinsland, Rosastr. 9, 7800 Freiburg i.Br., W. Germany), K.O. Münnich
Two north-south sections of the atmospheric concentration of Kr-85 are presented. The most striking feature of these sections is a large concentration jump at the respective geographical position of the Intertropical Convergence. Southern hemispheric residence times of 1 and 1.7 yrs resp. are estimated from the Kr-85 sections. The mean slope of the Kr-85 data observed between 10° and 40° S is in agreement with a meridional diffusivity of 1.8 · 10^{10} cm^2/sec. Five years of a continuous Kr-85 record from two stations in 47.9° N, 7.8° E (difference in altitude : 1000 m) show a mean concentration increase per year of 0.5 pCi/m^3, an apparent seasonal variability (amplitude 1 - 2 pCi/m^3), and numerous peaks. The peaks originate from European sites. The yearly contribution of this (these) source(s) to the global Kr-85 discharge is at least 18%. The apparent seasonal variability of the Kr-85 concentrations is tentatively explained by the seasonal variability of the vertical mixing of the atmosphere.
J. Geophys. Res., Green, Paper 3C1112

3740 General Circulation
ROTATING FLUID EXPERIMENTS WITH AN ATMOSPHERIC GENERAL CIRCULATION MODEL
J. E. Geisler (Department of Meteorology, University of Utah, Salt Lake City, UT 84112), E. J. Pitcher and R. C. Malone
The traditional apparatus for rotating-fluid experiments in the laboratory is an annular container of fluid situated on a turntable. A fundamental difficulty in applying to atmospheric circulation problems the knowledge and understanding of the behavior of rotating fluids gained from these experiments is the geometrical difference between a rotating annulus and a rotating spherical shell. With a view toward identifying features of rotating fluid flow that are dependent on the geometry, we have undertaken rotating-annulus-type experiments with a numerical model in spherical coordinates. Rather than construct and test a model specifically for this purpose, we found it expedient to modify an existing general circulation model of the atmosphere by removing the model physics and replacing the lower boundary with a uniform surface. We present here a regime diagram derived from these model experiments, interpret its major features, and contrast these with the major features of rotating-annulus regime diagrams. A narrow region where one or two zonal wavenumbers are dominant is found within the wave regime. In contrast to the situation in the annulus, there is no upper symmetric regime in our results, and wave activity at low rotation rates appears to be maintained by barotropic rather than baroclinic processes. (Rotating-fluid experiment, geophysical fluid dynamics)
J. Geophys. Res., Green, Paper 3C1079

3740 General Circulation
LONG AND MEDIUM-SCALE WAVES IN THE LOWER STRATOSPHERE FROM SATELLITE-DERIVED MICROWAVE MEASUREMENTS
Wan-bi Yu, Russell L. Martin and John L. Stanford (Physics Department, Iowa State University, Ames, Iowa 50011)
Global grids have been constructed from high-quality TIROS-N Microwave Sounder Unit measurements which closely approximate the 10-150 mb geopotential thickness. The grids compare favorably with conventional analyses. Grids for January 1979 are spectrally analyzed by Fourier transform for zonal wavenumbers 1-10 over latitudes 80N to 80S. Both time-mean and transient medium-scale waves are discussed in some detail. In the time mean, wave 1 dominates all northern latitudes. In equatorial regions wave 1 also is dominant, but a secondary spectral peak is noted at wave 4. The most remarkable feature seen is a strong, medium-scale wave structure with eastward movement in Southern (summer) mid-latitudes. Zonal wavenumbers 5 and 6 have periods of about 10-15 days and 5 days, respectively. These results provide independent corroboration of such structures recently reported by several investigators. The mechanism by which the dominant medium-scale waves are maintained is not understood.
J. Geophys. Res., Green, Paper 3C0800

3755
STAR LINE-OF-SIGHT REFRACTION OBSERVATIONS FROM THE ORBITING ASTRONOMICAL OBSERVATORY "COPERNICUS", AND DEDUCTION OF STRATOSPHERIC STRUCTURE IN THE TROPICAL REGION.
R.L. White (C.S. Draper Laboratory, Cambridge, MA 02139), S.E. Lenner and R.S. Polidan.
Sight-line observations from the Orbiting Astronomical Observatory COPERNICUS on May 14 and July 11, 1980, of visible light refraction by the limb of the atmosphere are presented. Irregularities of the measured refraction angle are interpreted to be the result of the thermal fine structure in the stratosphere. The observations are very sensitive to horizontally stratified structures with temperature variations of 2 to 5°K in narrow vertical bands, typical for the boundaries of wind ducts. This optical technique of remote sensing of atmospheric structure is particularly applicable to the altitude region of 25 to 40 km, where the vertical soundings by VHF and UHF tend to exhibit inadequate sensitivity.
J. Geophys. Res., Green, Paper 3C0594

3799 General Meteorology
A FREQUENCY DOMAIN ANALYSIS OF TRENDS IN DOBSON TOTAL OZONE RECORDS
P. Bloomfield (Dept. of Statistics, P.O. Box 37, Princeton University, Princeton, NJ 08544)
G. Oehlert, M.L. Thompson, S. Zeger.
A frequency domain statistical model for the Dobson total column ozone data is introduced. This model extends variance-components analysis to the time series case and incorporates both temporal and spatial association found in the ozone data. We estimate the change in total ozone possibly associated with chlorofluorocarbons to be a 0.1% increase from 1970 through 1979, with a standard error of 0.55%. This estimate is most sensitive to long term phenomena in the data and is relatively insensitive to phenomena with time scales less than 2 years.
J. Geophys. Res., Green, Paper 3C1018

Mineralogy, Petrology, and Crystal Chemistry

4160 Petrogenesis, petrography and petrogenesis
GRANITE PETROLOGY, ILLINOIS DEEP HOLE
Edward O. Lidiak (Geology and Planetary Science Department, University of Pittsburgh, Pittsburgh, PA 15260), Roger S. Denison
Two main basement granitoid types have been identified in core samples from the Illinois deep hole project. The main variety is a medium- to coarse-grained porphyritic biotite granite with phenocrysts of microcline perthite and less commonly quartz and sodic plagioclase in a matrix of these minerals and biotite, muscovite, fluorite, magnetite, ilmenite, zircon, hornblende, apatite, sphene, monazite, rutile, and clinopyroxene (relict). The texture is typically hypidiomorphic granular to recrystallized xenomorphic. The second main granitoid, which occurs in the upper part of hole UPH-3, is a fine-grained granoblastic to lepidoblastic gneissic granite that is distinct from and possibly older than the non-foliated granite. The textures of both rocks have been modified by a mild cataclastic shearing that has partially recrystallized the more susceptible mineral phases. Thin fracture planes that cross-cut the earlier foliations are common.
Microprobe analyses indicate that biotites in the gneissic granite are chemically distinct from those in the granite. Biotites in the gneissic granite have higher Fe/Fe + Mg ratios, FeO and Al_2O_3, and lower MgO and SiO_2. Reflection microscopy and microprobe analyses indicate that the oxide phases in the two rocks are also different. The oxides in the granite are magnetite and ilmenite, whereas hematite and pseudobrookite occur in the gneissic granite. The biotite and Fe-Ti oxide data represent additional evidence in support of the fact that the granite and gneissic granite are distinct rocks and probably not part of a continuous co-magmatic sequence.
Major element chemical analyses indicate that the granites have affinities to anorogenic rapakivi granites. The granites in the deep-holes are high in SiO_2, alkalis (Na_2O + K_2O), F, FeO/MgO; low in Al_2O_3, PeO, Fe_2O_3, TiO_2, MnO, and P_2O_5; and slightly low in MgO and CaO.
Magnetic susceptibility and density measurements correlate generally well with magnetic susceptibility and density logs. Magnetic susceptibilities range from 80-17,000 micro SI units, higher values correlate mainly with greater amounts of Fe-Ti oxides and biotite; lower values with gneissic rocks and muscovite content. Density measurements range from 2.595-2.685 Mg/m^3; denser rocks correlate positively with higher amounts of biotite and Fe-Ti oxides and inversely with microcline perthite content.
J. Geophys. Res., Red, Paper 3B0843

Oceanography

4705 Boundary layer and exchange processes
HEAT FLUXES OVER THE EASTERN TROPICAL PACIFIC AND ASPECTS OF THE 1972 EL NIÑO
R. K. Reed (Pacific Marine Environmental Laboratory, NOAA, Seattle, Washington 98105)
Recently evaluated flux formulas were used with an edited ship-of-opportunity data set for the 1970's decade to derive estimates of the individual surface heat fluxes and the total or net surface energy exchange for the eastern tropical Pacific. Absorbed solar radiation is the dominant heat flux in the region, and latent heat exchange is the second most important component; total cloud cover and wind speed are generally the most significant atmospheric variables. Over much of the area, the annual excess of net surface flux appears to be balanced by heat advection in the South Equatorial Current. Although the seasonal cycles of sea surface temperature seem to be produced by variations in net surface flux over parts of the area, they do not appear to balance off Peru and near the equator. Instead, water temperature seems to be noticeably affected by the seasonal cycle of upwelling and advection along the Peru coast.
This data set was also used to derive sea surface temperature and net surface heat flux departures from the mean for individual months during the 1972 El Niño. The magnitude and speed of the initial warming along the eastern ocean margin indicate changes in heat content at least an order of magnitude greater than any departures of net surface flux; this fact and the subsequent poleward and westward spreading of warm water support an advective origin, especially Wyrtki's hypothesis of an eastward propagating Kelvin wave. Subsequent changes during an El Niño episode also do not seem to be influenced appreciably by variations in surface heat exchange. (Heat fluxes, heat advection, El Niño).
J. Geophys. Res., Green, Paper 3C1139

4713 Circulation
EDDY ENERGY OF THE NORTHWEST ATLANTIC DETERMINED FROM GEOS-3 SATELLITE ALTIMETER DATA
B.C. Douglas (NOAA National Ocean Service, Rockville, MD 20852), R.E. Cheney and S.V. Agreen
From May 1975 to October 1978 the Geos 3 satellite altimeter made numerous repeated observations of sea surface topography in the North Atlantic, Caribbean, and Gulf of Mexico. By comparing members of about 1000 collinear pairs of altimeter profiles, we have determined mesoscale sea height variability and eddy kinetic energy in these ocean regions. Our results agree qualitatively with estimates made from traditional oceanographic surveys, but significant quantitative differences exist in certain areas, especially in the Gulf Stream between Florida and Cape Hatteras where the altimetric results show less variability. The reason for this appears to be due to differences in spatial sampling. Historical oceanographic measurements are relatively sparse and must be aggregated into small geographic boxes to compute variability statistics. Results therefore represent a combination of temporal and spatial variability. In contrast, repeated satellite altimeter tracks provide point measurements of changes of sea height and slope, enabling determination of temporal variability alone, a quantity more representative of eddy energy. It is important to make this distinction between space and time because in regions of strong horizontal gradient such as the Gulf Stream, spatial variability can exceed the temporal component. In mid-ocean where spatial variability is negligible, altimetric and oceanographic results are in excellent agreement. (Altimetry, Gulf Stream, satellite techniques, mesoscale variability).
J. Geophys. Res., Green, Paper 3C1111

4740 Marine geological processes
A STUDY OF THE OPTICAL CHARACTERISTICS OF THE SUSPENDED PARTICLES IN THE BENTHIC NEPHELOID LAYER OF THE SCOTIAN RISE
R. W. Spinrad (Bigelow Laboratory for Ocean Sciences, McKown Point, W. Boothbay Harbor, Maine, 04575), J. R. V. Zaneveld and J. C. Kitchen
Light transmission profiles have been used to study the optical properties of the suspended particles which are characteristic of the area of the Scotian Rise in the North Atlantic Ocean. This area is typified by very strong bottom currents and a highly variable bedform morphology. A good correlation (r = 0.90) has been found between the suspended volume and the light beam attenuation coefficient. This correlation is consistent with the fact that the cumulative slope of the hyperbolic particle size distribution is nearly constant throughout the region (slope = 3.1 ± 0.3). Numerical analysis of the optical data in conjunction with particle size analysis yields values of the index of refraction of the suspended particles of 1.20 ± 0.07 relative to water. The conclusion drawn from these results is that the Scotian Rise benthic zone is characterized by suspended particles of high relative index of refraction and also distributions which do not vary much with altitude above bottom or over periods of time of more than a year in spite of the extensive fluctuations in activity of the region. (Optical, particles, nepheloid layer, Scotian Rise)
J. Geophys. Res., Green, Paper 3C1020

4790 Instruments and Techniques
WIND MEASUREMENTS FROM AN ARRAY OF OCEANOGRAPHIC MOORINGS AND FROM F. S. METEOR DURING JASIN 1978
S. S. Weller (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 02543), R. E. Payne, W. G. Large, and W. Zenk
During the Joint Air-Sea Interaction (JASIN) experiment conducted in the northern Rockall Trough in the summer of 1978 an oceanographic moorings with surface buoys carrying wind recorders were deployed in an array designed to investigate the variability of the near-surface wind field at scales of from 2 to 200 km. The wind records together with observations taken on board the research vessels participating in JASIN have provided ground truth measurements for the sea surface wind velocity sensors on the SEASAT satellite. During most of the experiment the wind field was characterized by spatial scales large compared to the separations between the buoys. On several occasions spatial differences associated with cold fronts were identified and it was possible to track the passage of the front through the array. However, quantitative analysis of the variability of the wind field was complicated both by a lack of data due to mechanical failures of some instruments and by significant differences in the performance of the diverse types of wind recorders. Re-evaluation of the instruments used in JASIN and recent comparison of some of these instruments with more conventional sets of wind sensors confirm the possibility that there is significant error in the JASIN wind measurements from the buoys. In particular, the Vector Measuring Wind Recorder on W2, which was one of the few instruments to recover a full length record and did well during a SEASAT-JASIN workshop as the JASIN standard, had performance characteristics that are among the most difficult to explain. (Wind measurements, JASIN).
J. Geophys. Res., Green, Paper 3C1111

Particles and Fields—Interplanetary Space

5160 Solar wind interactions with moon and planets
PLASMA DISTRIBUTIONS AND MAGNETIC FIELD ORIENTATIONS IN THE VENUS NEAR WAKE; SOLAR WIND CONTROL OF THE NIGHTSIDE IONOPAUSE
H. Perez-de-Tejada (Instituto de Geofisica, Ensenada, Baja California, Mexico), H. Mayr, ... Intriligator, C. T. Russell, and L. H. Brace
A comparative study of the position of the nightside ionopause and of the orientation of the magnetic field in the near Venus wake is presented. It is shown that when the ionopause is detected near the umbra the magnetic field vector along the wake shows consistently a convergent orientation toward the Sun-Venus axis. When the ionopause is located outside the umbra, the magnetic field may have directions not necessarily indicative of closure. The overall configuration of the nightside ionopause is, in addition, to be strongly controlled by the energy density of the solar wind. At high values of this quantity the ionopause tends to occur favorably at low heights. (Venus ionopause, solar wind, magnetic field lines).
J. Geophys. Res., Blue, Paper 3A0810

5140 Solar wind plasma
REFLECTION OF THE SOLAR WIND IONS AT THE EARTH'S BOW SHOCK: ENERGIZATION
C. Bonifazi (Space Science Department of ESTEC, Noordwijk, The Netherlands), G. Moreno and F.E. ...
The energies of the "reflected" ion beams observed at the Earth's foreshock are tested, on a statistical basis, against a simple reflection model. The comparison is carried out using plasma and magnetic field measurements on ISEE-2 during the period from November 1 to November 20, 1977. According to this model, some of the solar wind ions incident upon the Earth's shock front, after reflected upstream, gain energy by displacement parallel to the interplanetary electric field. The energy gain in the reflection can be described as a function of the angles between the interplanetary magnetic field, the solar wind bulk velocity, and the local shock normal. The local shock normal has been calculated with a model which allows us to use the ion beam observations even when far from the shock (at distances up to 10⁵ km). We confirm, on a statistical basis, the good agreement between observations and predictions recently found using 18 ion beam events, all observed very close to the shock, from the LASL/MPE instruments on ISEE-1 and -2. We infer that the "reflected" ion beams can easily propagate far upstream of the Earth's bow shock without changing their energy properties ("reflected" ions, ISEE, Foreshock).
J. Geophys. Res., Blue, Paper 3A1035

5199 General (Upstream ions)
UPSTREAM GYROPHASE BUNCHED IONS: A MECHANISM FOR CREATION AT THE BOW SHOCK AND THE GROWTH OF VELOCITY SPACE STRUCTURE THROUGH GYROPHASE MIXING
C. Gurgiolo (Southwest Research Institute, P.O. Drawer 28510, San Antonio, Texas 78284), G. K. Parks and B. H. Mauk
The conditions necessary for the production of gyrophase bunched ions at the bow shock are derived. The conditions are applied to the reflection model presented by Paschmann et al. (1980) showing that in their model, a portion of the incident parallel velocity is converted into reflected perpendicular velocity, the reflected particles are gyrophase bunched. The growth of velocity space structure in the gyrophase bunched distribution through gyrophase mixing is explored. The structure is found to be similar to that reported in diffuse and dispersed ion events. This, together with the close correlation of the observation of gyrophase bunched ions with diffuse and dispersed ions has led us to speculate that these two populations may be closely related. (Upstream ions, gyrophase bunching, reflection mechanisms, bow shock).
J. Geophys. Res., Blue, Paper 3A1036

Particles and Fields—Ionosphere

5510 Auroral zone magnetic effects
TRIGGERING OF EXPANSIVE PHASE INTENSIFICATIONS OF MAGNETOSPHERIC SUBSTORMS BY NORTHWARD TURNINGS OF THE INTERPLANETARY MAGNETIC FIELD
Gordon Rostoker (Institute of Earth and Planetary Physics and Department of Physics, University of Alberta, Edmonton, Alberta, Canada T6G 2J1)
Over the past decade evidence has arisen suggesting that northward turnings of the interplanetary magnetic field after an interval of sustained southward IMF may trigger the onset of major substorm expansive phase effects. However, there has been some question as to just how many substorms are triggered and whether, indeed, the correlation of substorm onsets and northward turnings was just a matter of chance. One reason for doubt was that the examples presented in the literature appeared during disturbed periods when the IMF was fluctuating significantly on a time scale of less than one hour and many substorm expansive phase intensifications were observable in the time frame where the correlation between the IMF and ground data was reported. The purpose of this paper is to present three clear-cut examples of isolated substorms where the reader may be able to convince himself of the validity of the reported triggering effect. For these events, it will be clear that the substorm current wedge triggered by the northward turning of the IMF carries substantially larger currents than the driven system associated with the overall substorm event. The role of the IMF in externally triggering episodes of Joule heating and particle precipitation within the substorm process will be discussed.
J. Geophys. Res., Blue, Paper 3A1023

5515 Aurora
A QUANTITATIVE DESCRIPTION OF THE SPATIAL DISTRIBUTION AND DYNAMICS OF THE ENERGY FLUX IN THE CONTINUOUS AURORA
J.A. Whalen (Air Force Geophysics Laboratory, Hanscom AFB, MA 01731).
Energy flux in the continuous (or diffuse) aurora is found to be constant instantaneously along contours which are defined analytically as a function of geomagnetic latitude and MT, coordinates which are approximated by circles in magnetic latitude-magnetic local time coordinates at a pole offset from the magnetic pole. As a consequence, the latitudinal distribution in their coordinates is the same instantaneously at all magnetic local times (the observed extent of which is 10 hr). Changes take place in the distribution do so simultaneously (within 10 minute UT resolution) throughout this extent.
These properties are observed in a case study of 8 hours duration by an array of ground and air based ionospheric sounders which span the 10 hours of magnetic local time at auroral latitudes. Energy flux of the continuous aurora is derived from the relation between auroral E-layer critical frequency which is measured simultaneously at 15 minute intervals by all members of the array.
Two latitudinal distributions are identified. The principal one is a Gaussian distribution at lower latitude; a separate distribution which is of lower intensity occurs at higher latitude; the two correspond respectively to the central plasma sheet and boundary plasma sheet regions of particle precipitation. The central plasma sheet distribution is found in all 32 determinations to be well described by a single Gaussian function, the width of which, full-width-at-half-maximum, accordingly the width of the entire latitude-local time distribution is described quantitatively by the time history of two parameters, the Gaussian maximum energy flux and the width, which varies between extremes of 0.26 and 7 ergs/cm² sec and of the latitude of the maximum (which varies throughout a range of 6°). The determination of these parameters every 10 minutes resolves such rapidly varying features as substorm onset; the 8 hour duration of the study reveals long term features of substorm lifetime and the progression of latitude variation. A number of areas of agreement are found between results reported here and those reported by others. In particular, evidence that the continuous aurora is highly uniform exists not only in this case study but also in statistical studies which show the offset circular energy flux contours to be offset circles. (Aurora, particle precipitation, ionospheric sounding).
J. Geophys. Res., Blue, Paper 3A0980

5520 Electric fields
EVIDENCE FOR THE E x B DRIFT OF PULSATING AURORAS
R.W.J. Scourfield (Physics Department, University of Natal, Durban 4001, South Africa), J.G. Keys, E. Nielsen, and C.K. Goertz.
Simultaneous measurements of ionospheric electric fields by STARE and TV imaging of pulsating auroral forms strongly suggest that the latter undergo E x B drift. A display of pulsating aurorae is considered as the projection on the ionosphere of an assembly of ducts of enhanced plasma density convecting with the background plasma. Energetic electrons, convecting and with additional gradient and curvature drift, sweep through these ducts which are "illuminated" by pulsating precipitation of these energetic electrons. Both the cell sustained pulsation model of Davidson (1979) and the driven pulsation model of Coroniti and Kennel (1970) are compatible with our observations. (Electric fields, pulsating aurora particle precipitation).
J. Geophys. Res., Blue, Paper 3A1102

5530 High-latitude Ionospheric Currents
RELATIVE CONTRIBUTION OF IONOSPHERIC CONDUCTIVITY AND ELECTRIC FIELD TO THE AURORAL ELECTROJETS
T. Kamide (NOAA Space Environment Laboratory, Boulder, Colorado 80303) and J. F. Vickrey
Data from continuous scans of the Chatanika radar beam along the magnetic meridian plane are utilized to determine the latitudinal profile of height-integrated ionospheric conductivities and horizontal electric fields, from which the latitudinal distribution of ionospheric currents is deduced. The observations cover invariant latitudes between 62° and 68°, where the IMS Alaska meridian chain of magnetometers was also in operation. Although the conductivities and the electric fields are interrelated, the relative importance of the two in driving the eastward and westward auroral electrojet currents can be assessed. It is found that for moderate and large current densities (i.e., ≳ 0.2 A/m), the northward electric field strength increases as the magnitude of the eastward electrojet in the evening sector increases. The height-integrated Hall conductivity stays generally at the level of 10 mhos even when the current density becomes as large as 1 A/m. However, when the eastward electrojet is small, substantial electric fields of 10-25 mV/m may still exist as if the magnetosphere has a persistent voltage source. There appear to be two distinct components to the westward electrojet. In the midnight and early morning sectors (<0300 MLT) intensity is characterized by a weak southward electric field and a high Hall conductivity, whereas its late morning portion (>0300 MLT) is dominated by a strong southward electric field.
J. Geophys. Res., Blue, Paper 3A1104

5520 Interactions between waves and particles
ENERGETIC ELECTRON PRECIPITATION DUE TO GYRORESONANT INTERACTIONS IN THE MAGNETOSPHERE INVOLVING COHERENT VLF WAVES WITH SLOWLY VARYING FREQUENCY
[illegible]
J. Geophys. Res., Blue, Paper 3A0607

5530 Ion densities and temperatures
PHOTOCHEMISTRY OF N_2^+ IN THE DAYTIME F-REGION
E. L. Breig (Center for Space Sciences, University of Texas at Dallas, Richardson, Texas 75080), W. B. Hanson, J. H. Hoffman and W. A. Abdou
The photochemistry of N_2^+ in the daytime F-region continues to be a source of concern, due primarily to the uncertain roles of the metastable $O^+(^2D)$ ion and possible vibrational excitation. This investigation employs a unique subset of data from the Atmosphere Explorer-C satellite that spans distinct regions near the low latitude F-peak wherein either chemical reactions or electron processes alternatively control the N_2^+ abundance. Concentrations of N_2^+ calculated according to current theory and including recent laboratory data for $O^+(^2D)$ losses via N_2 are found to exceed ionospheric observations between 220 and 400 km by a factor near 2. Relevant characteristics of the basic molecular ion concentration measurements are described, along with an analysis for salient results conducted according to current photochemical equilibrium theory. Possible simple modifications of this theory are discussed in terms of the constraints suggested by the nature of the observations. (Photochemistry, ionosphere, molecular ions)
J. Geophys. Res., Blue, Paper 3A1045

5545 Ionospheric Disturbances
THE FOSSIL THEORY OF NIGHTTIME HIGH LATITUDE F-REGION TROUGHS
J V Evans (COMSAT Labs, 22300 Comsat Drive, Clarksburg, MD 20871), J. M. Holt, W. L. Oliver, and R. H. Wand
Observations of F-region electron density, electron and ion temperatures and ion drift velocity over the latitude interval 40° ≤ Λ ≤ 70° have been made from Millstone Hill by means of incoherent scatter radar. We conclude that the F-region density trough that forms on the night side of the earth may have more than one cause. Current computer models indicate that it can be produced as a consequence of the competing effects of convection and corotation which cause some flux tubes to remain for long periods in darkness in the premidnight sector, thereby allowing the ionization in them to decay. Our observations show that troughs often are first seen in the late afternoon sector in regions of fast sunward convective flow and can move in latitude in association with substorms. We suggest that these troughs are produced by convection of low density regions from the nightside into daylight and the increased recombination rate that occurs in regions where the O^+ ions are forced through the neutral air at high speed (~ 1 km/sec). Troughs created in the dusk sector by this mechanism during substorms can be left as the ionospheric signature of the substorm or "fossil" when the region of fast convective flow moves poleward following the substorm. These extended E-W troughs then are carried across the nightside of the earth by corotation. Relative to the surrounding regions, the trough changes little with time, and finally is destroyed only when it is carried into sunlight on the dawn side.
J. Geophys. Res., Blue, Paper 3A1046

5545 Ionospheric disturbances
ANALYSIS AND NUMERICAL SIMULATION OF THE EFFECT OF ION PEDERSEN MOBILITY ON IONOSPHERIC BARIUM CLOUDS*
S.T. Zalesak (Code 4780, Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375), J.A. Fedder and S.L. Ossakow
We analyze the effect of finite ion Pedersen mobility on the evolution of ionospheric barium clouds. We find that the Pedersen mobility provides a mechanism whereby barium can leak out of the region of elevated magnetic-field-line integrated electron density/Pedersen conductivity and hence lose the ability to structure further. The essence of the mechanism is that the finite Pedersen mobility of the barium ions allows them to separate from the cloud electrons, which have virtually no Pedersen mobility. The barium is replaced in the electron cloud by the ions constituting the ambient ionosphere, which are compressed up to the required densities by their own Pedersen mobility. (Here we take the "electron cloud" to be that defined by regions of enhanced magnetic-field-line integrated electron density, not by local electron density enhancement). In the process of exiting the electron cloud, the barium is expanded and hence attains a density lower than when it coexisted with the electron cloud. For many ionospheric parameters the barium will have in effect left the region of further structuring, which will still be proceeding in the electron cloud. As the barium leaves the electron cloud, it can form a long thin sheet of lower density barium, one side of which is considerably steeper than the other, which extends from the leading (non-structuring) edge of the cloud. An observer watching only the barium or only local electron densities would conclude that the structuring process had ceased. Further, the electron cloud itself may decay if the ions coexisting with it are subject to a fast recombination chemistry. (Barium clouds, ion clouds, striations, Pedersen mobility).
*Work supported by the Defense Nuclear Agency
J. Geophys. Res., Blue, Paper 3A0922

5545 Ionospheric Disturbances
THEORIES OF HIGH LATITUDE IONOSPHERIC IRREGULARITIES: A REVIEW
S.T. Keskinen (Naval Research Laboratory, Washington, D.C. 20375) and S.L. Ossakow
A review of theories of naturally occurring high latitude ionospheric irregularities, structures, and striations is presented. Both E and F region irregularities are discussed with irregularity source mechanisms emphasized. Recent theoretical results are stressed and outstanding problems identified.
Rad. Sci., Paper 3S0639

5550 Airglow
DEPENDENCE OF AURORAL FUV EMISSIONS ON THE INCIDENT ELECTRON SPECTRUM AND NEUTRAL ATMOSPHERE
D.J. Strickland (Beers Associates, Inc., Post Office Box 2549, Reston, Virginia 22090), J.R. Jasperse and J.A. Whalen.
In this paper we examine the relationship among certain prominent auroral FUV emission features, the incident electron spectrum, and the model neutral atmosphere. Given the neutral atmosphere we show that for simple models of the incident electron spectrum (Maxwellian and Gaussian in energy) satellite measurements of FUV emission features, in principle, determine the incident electron spectrum. We also discuss the relationship between the incident electron spectrum and the E-region plasma density profile for the continuous (diffuse) aurora and for a stable arc. (FUV emissions, aurora, electron transport).
J. Geophys. Res., Blue, Paper 3A0370

5550 Low - latitude ionospheric currents
A THEORETICAL MODEL OF EQUATORIAL F-REGION DYNAMICS
S. Duhau (Departamento de Fisica, Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Ciudad Universitaria, 1428, Buenos Aires, Argentina), and A. Louro
A simple dynamical model of the equatorial F-region is presented, in which this section of the ionosphere is coupled to the E-region, which is represented by a thin horizontal current layer, and the vertical current density at the base of the F region is taken to be composed entirely of current normal to the geomagnetic field lines, according to a previous finding by the authors. The new boundary condition for the current density at the interphase between the E- and F- layers simplifies the system of equations. The model is applied to calculate the zonal ion velocity and the vertical current at the boundary between the F- and E- regions.
J. Geophys. Res., Blue, Paper 3A0659

550 Low - latitude ionospheric currents
THE CURRENT FLOW BETWEEN THE EQUATORIAL E AND F REGIONS
S. Duhau (Departamento de Fisica, Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Ciudad Universitaria, 1428, Buenos Aires, Argentina), and A. Louro
In dynamical calculations in the equatorial F-region it is usually assumed that the current flowing through the base of the F region does so exclusively along the geomagnetic field lines. This hypothesis is revised in the present paper and it is found that the major contribution to the total flow at that height is given by the current normal to the field lines.
J. Geophys. Res., Blue, Paper 3A0058

5560 Particle precipitation
AURORAL ELECTRON BOUNDARIES AND IMF B_z
K. Makita* (Applied Physics Laboratory, The Johns Hopkins University, Laurel, Maryland, 20707), C.-I. Meng and S.-I. Akasofu
On the basis of the auroral precipitating electron data, along the dawn-dusk meridian, from a Defense Meteorological Satellite Program satellite (DMSP-F2), we show that the electron precipitation region extends poleward, often to the geomagnetic latitudes > 85° from the average oval location, during quiet periods (namely, during periods of a large positive B_z component). This result may be interpreted as an indication that only a small amount of geomagnetic flux interconnects with the northward IMF, resulting in a contracted 'open' region (the polar cap). The control of the location of the poleward boundary by the north-south component of the IMF is also statistically examined. The rate of latitudinal movement is about 0.4° to 0.8° per 1 nT for positive IMF B_z values and about 0.1° to 1.1° per 1 nT for negative IMF B_z values. The shift of the equatorward boundary is, however, not obvious for positive IMF B_z values. As geomagnetic activity increases, both the poleward and equatorward boundaries shift towards lower latitudes. The equatorward shift of the poleward boundary is greater than that of the equatorward boundary, resulting in a thinner electron precipitation region during disturbed periods than during quiet periods.
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J. Geophys. Res., Blue, Paper 3A1037

5560 Particle precipitation
IMPULSIVE PARTICLE PRECIPITATION AND CONCURRENT MAGNETIC FIELD CHANGES OBSERVED IN CONJUGATE AREAS NEAR L=4
L. J. Lanzerotti (Bell Laboratories, Murray Hill, N.J. 07974) and I. J. Rosenberg (IPST, University of Maryland, College Park, Maryland 20742).
Using sensitive riometers (30 MHz) and magnetometers at Siple Station, Antarctica, and at four locations in the conjugate area in the northeastern United States and southern Quebec, we have studied the temporal and spatial extent of the impulsive losses of electrons from the radiation belts and the concurrent accompanying magnetic field variations produced by the changes in ionospheric current systems. The impulsive variations have a short (~2-4 sec.) onset time and a ~5-10 sec. decay time. The observed decay times in the riometer and magnetometer signal are consistent with the recombination times in the ionosphere at ~90-100 km. Often the magnetic field fluctuations are observed to occur primarily in the east-west direction, and are out of phase between the southern and northern hemisphere. These observations suggest that predominantly north-south ionospheric currents are modified and/or produced by such impulsive precipitation. Time delays in the occurrence of the events between the northern and southern hemispheres, as well as time and spatial differences observed between the northern hemisphere stations, suggest that irregularly-shaped, gradient-B drifting patches of precipitating electrons could be the source of these impulsive events. (Ionosphere currents, electron precipitation, geomagnetic fluctuations).
J. Geophys. Res., Blue, Paper 3A1047

5561 Plasma motion, convection or circulation
O^+ IONS IN THE POLAR WIND
A. R. Barakat (Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah 84322), and R. W. Schunk
A semi-kinetic model was used to describe the steady state collisionless flow of the polar wind along diverging geomagnetic field lines at high latitudes. Emphasis was given to studying the behavior of O^+ ions for a wide range of boundary conditions at the baropause (A300 km). The main result obtained was that for high electron temperatures (T_e ~ 10,000 K) O^+ is not gravitationally bound and significant escape fluxes (~10^7 cm^{-2} s^{-1}) of suprathermal (~2 eV) O^+ ions occur. The O^+ flow is supersonic over most of the altitude range considered, and O^+ Mach numbers as large as 10 are predicted at 10 R_E. Also depending on the boundary conditions, the O^+ density can be comparable to or greater than the H^+ density at high altitudes above the baropause when the electron temperature is high.
J. Geophys. Res., Blue, Paper 3A1137

5560 Wave Propagation
HF RAYTRACING AT HIGH LATITUDES USING MEASURED MERIDIONAL ELECTRON DENSITY DISTRIBUTIONS
J. P. Villain (Laboratoire de Sondages Electromagnétiques de l'Environnement Terrestre, Université de Toulon, Bld des Armaris, 83100 Toulon, France), R. A. Greenwald and J. F. Vickrey
In many physical cases, small and intermediate scale (1-100m) electron density irregularities in the ionospheric E and F-region are elongated in the direction of the Earth's magnetic field. As a result of this elongation or field-alignment, radar studies directed toward the analysis of backscattered signals from ionospheric irregularities require that the radar wave-vector propagate perpendicular to the magnetic field in the irregularity region. At low and middle latitudes orthogonality may be achieved at any radar operating frequency, but at higher latitudes this geometry becomes increasingly difficult. Above 40° invariant latitude it is almost impossible to achieve normality with straight line propagation. In order to observe the wealth of ionospheric irregularities in the auroral zone and polar cap E- and F-region, one must operate radars at HF frequencies where refraction effects wave propagation and aids one in achieving the orthogonality condition, however refraction from large scale (1-100km) ionospheric irregularity structure also increases the complexity in accurately determining the location of the scattering volume. In this paper we use a modified version of an existing HF ray tracing program to determine with high precision the HF propagation paths in a realistic ionosphere. In this analysis the ionosphere is simulated by a two-dimensional array of electron density as a function of geomagnetic latitude and altitude. This analysis is then applied to real measurements obtained from a meridian scan of the Chatanika incoherent scatter radar and we show how this electron density distribution affects propagation from a simulated HF radar located at Anchorage, Alaska. The variations of the propagation conditions are also studied as one moves the density pattern in the direction of the Anchorage radar.
Rad. Sci., Paper 3S1009

5580 Wave Propagation (Ionosphere)
VLF REFLECTION PROPERTIES OF THE NORMAL AND DISTURBED POLAR IONOSPHERE IN NORTHERN GREENLAND
F. A. Kossey (Propagation Branch, Rome Air Development Center, Hanscom Air Force Base, Massachusetts 01731), J. P. Turtle, R.P. Pagliarulo, W. I. Klemetti and J. E. Rasmussen
Long wave reflection properties of the high latitude ionosphere under both quiet and highly disturbed conditions, are described. The data were obtained using a short-pulse VLF ionosounder located within the polar cap, in northern Greenland. Under quiet ionospheric conditions substantial diurnal, day-to-day, seasonal, and solar cycle variations were observed. During polar cap absorption events the VLF reflection properties of the disturbed ionosphere depended greatly on the solar illumination conditions, as well as the magnitude of the in-coming energetic particle flux. The use of the steep-incidence VLF reflection data to develop and validate models of the lower ionosphere is discussed; and, electron density profiles are given, derived from reflection data obtained during quiet and disturbed conditions. (Low frequency, D-region, absorption events).
J. Geophys. Res., Green, Paper 3C0640

5580 Wave propagation
ALOUETTE-ISIS RADIO WAVE STUDIES OF THE CLEFT, THE AURORAL ZONE AND THE MAIN TROUGH AND OF THEIR ASSOCIATED IRREGULARITIES
D.B. Muldrew (Communications Research Centre, P.O. Box 11490, Station "H", Ottawa, Ontario, CANADA K2H 8S2)
The principal high-latitude ionospheric features such as the cleft, the nighttime auroral zone, the main trough and their associated irregularities, as observed with the Alouette/ISIS topside sounders, are reviewed. These features can be clearly distinguished in Alouette-1 electron density contour plots as a function of latitude and height below 1000 km. Alouette 2 data recorded near apogee (3000 km) show the location of the light-ion (H⁺ and He⁺) trough as a function of local time and show it to be more closely related to the plasmapause than is the main trough. An attempt is made to clarify the location and terminology of trough-like structures. Regions of small-scale irregularities (tens of meters) are associated with the high-latitude ionospheric features. These irregularities are responsible for the presence of aspect-sensitive spread F on topside ionograms. The most intense spread is found in the cleft region. Spread-F regions usually have a sharp equatorward boundary. Some recent unpublished work by the author, indicates that the spread-F boundary for the nighttime auroral zone tends to be located several degrees equatorward of the keV electron precipitation zone and is probably generated indirectly by this precipitation and convected equatorward. In the main trough region spread is sometimes present and other times absent. Some of the individual small-scale irregularities responsible for spread F can extend along magnetic-field lines for hundreds of kilometers. (Cleft, auroral zone, main trough, irregularities.)

5590 Instruments and techniques
INITIAL STUDIES OF SMALL-SCALE F REGION IRREGULARITIES AT VERY HIGH LATITUDES
R. A. Greenwald, K. B. Baker (Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland, 20707) and J. P. Villain
In this paper we describe a recently developed HF radar system designed to study F region irregularities at high latitudes. The radar utilizes a 7-pulse multipulse sequence enabling it to determine 17-lag autocorrelation functions of E and F region irregularities. These autocorrelation functions and the associated Doppler spectra are not subject to the range-frequency ambiguity that occurs with other spectral techniques. The radar has been operated from the Cleary field site near Fairbanks, Alaska, for a short period in February 1981. The primary field of view of these measurements was poleward of Inuvik in northwestern Canada. Initial results from these measurements indicate a great deal of spatial and temporal variability in the irregularity Doppler characteristics; however, the overall pattern is generally consistent with the nominal pattern of very high latitude convection. Some anomalies existed, including evidence of an appreciable component of dawn-dusk drift near the most poleward latitudes of observation in the dawn local time sector.
Rad. Sci., Paper 3S0881

5500 General (Spacecraft Charging)
MECHANISMS THAT LIMIT POTENTIALS ON IONOSPHERIC SATELLITES
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For spinning satellites with dielectric coatings it is shown that ion currents of rotating charge embedded in the dielectric surface can play a role in limiting the spacecraft ground potential of an ionospheric satellite relative to the surrounding plasma. Such currents, as well as small concentrations of H⁺, can account for previous discrepancies of more than a factor of two between measured and calculated potentials of satellites in the region of the ionosphere where O⁺ is dominant. More generally, dielectric conduction can also limit the satellite potential. The importance of such small currents as result from spin and conduction stems from the extremely small ion currents impinging on the wake-side of the satellite. Finally, theoretical estimates based on a newly described constant of the motion of a particle indicate that accounting for small concentrations of H⁺ remove the major discrepancy between calculated and measured currents on the wake-side of the AE-C satellite. (Charging, electric field, particle measurements).
J. Geophys. Res., Blue, Paper 3A1051

Particles and Fields—Magnetosphere

5705 (Bow Shock)
STRUCTURE OF THE QUASI-PARALLEL BOW SHOCK: RESULTS OF NUMERICAL SIMULATIONS
J.R. Kan (Geophysical Institute, University of Alaska, Fairbanks, Alaska, 99701) and D.W. Swift
Quasi-parallel bowshock structures are simulated using a one-dimensional nonperiodic hybrid code in which the ion dynamics are treated exactly while the electron dynamics are omitted by neglecting the electron inertia (m_e = 0) and pressure. The simulations are initialized with the upstream condition specified by θ_1 = 10°, β_1 = 0.3 and M_{A1} = 2 to 4 with 0.5 increment while the downstream condition is obtained from the Rankine-Hugoniot relations, where θ_1 is the angle between the shock normal and the magnetic field, β_1 is the ratio of kinetic to magnetic pressure and M_{A1} is the Alfvén Mach number. The main results of our simulations are: (i) For M_{A1} < 3, the magnetic field profile of the shock is laminar or quasi-laminar. The upstream waves are right-hand polarized whistlers with ω ≈ 1.1Ω in the plasma frame, where Ω is the ion gyrofrequency based on the normal field component B_n. This corresponds to a wave frequency f ≈ 0.25 Hz and wavelength λ ≈ 310 km under solar wind conditions. The downstream waves are absent or low in amplitudes. (ii) For M_{A1} > 3, the magnetic field profile of the shock is turbulent. The upstream waves are again right-hand polarized whistlers with wavelengths varying from λ ≈ 510 km upstream to λ ≳ 1250 km downstream. The downstream waves are predominantly the right-hand polarized fast magnetosonic waves (ω ≲ Ω). (iii) The transition from the laminar (subcritical) to the turbulent (supercritical) shock structures is shown to result from the firehose instability which occurs when M_{A1} ≳ 3. (iv) The dissipation mechanism for the quasi-parallel shock in our simulation is identified with the nonadiabatic compression of ions streaming through the low frequency whistler waves (ω ≲ Ω), resulting in conversion of ion streaming energy to ion thermal energy. (v) Significant ion heat flux flowing upstream occurs when M_{A1} ≳ 3, is due primarily to the backscattering of highly nonadiabatically heated ions.
J. Geophys. Res., Blue, Paper 3A0978

5715 Electric Fields
A STATISTICAL STUDY OF LARGE ELECTRIC FIELD EVENTS IN THE EARTH'S MAGNETOTAIL
S. Levin (Physics Department and Space Sciences Laboratory, University of California, Berkeley, California, 94720), K. Whitley, and F. S. Mozer
A statistical study of large electric field events, measured on ISEE-1 at geocentric distances of 3 to 11 R_E, has been performed in order to determine the occurrence frequency and spatial distribution of such events. Large electric fields were seen at all altitudes, with the lowest altitude events occurring on auroral field lines and the higher altitude events occurring on the high latitude boundary of the plasmasheet. The largest events had amplitudes that were approximately proportional to the square root of the local magnetic field strength, in agreement with expectations of a simple mapping model. The apparent concentration of big field events near local midnight is caused, at least in part, by a nonuniform frequency of satellite crossings through the plasmasheet boundary as a function of local time. Thus, the spatial distribution and amplitudes of the large field events are not inconsistent with the mapping of low-altitude electrostatic shocks to the plasmasheet boundary along equipotential magnetic field lines.
J. Geophys. Res., Blue, Paper 3A1048

5720 Interactions between solar wind and magnetosphere
RADIO EMISSION SIGNATURE OF SATURN IMMERSIONS IN JUPITER'S MAGNETIC TAIL
M. D. Desch (NASA/Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, MD, 20771)
During the interval from about May through August 1981, when Voyager 2 was inbound to Saturn, the Planetary Radio Astronomy instrument measured repeated, dramatic decreases in the intensity of the Saturn Kilometric Radiation (SKR). The emission dropouts averaged two orders of magnitude below mean energy levels and varied from about 1 to 10 Saturn rotations in duration. Comparison with pre-Saturn encounter Voyager 1 observations (dating to November, 1980) shows that the SKR dropouts were unique to the Voyager 2 observing interval, consistent with the closest proximity of Saturn to Jupiter's distant magnetotail in 1981. Further, the dropouts occurred on the average at times when Voyager 2 is known to have been within or near Jupiter's magnetic tail. Interpretation of these events as the radio signatures of successive Saturn immersions into Jupiter's tail or wake region is consistent with the independent evidence that the SKR radio source is driven externally by the solar wind ram pressure. The dropouts are identical to the one observed just after Voyager 2 closest approach to Saturn, providing the best evidence that Saturn was within Jupiter's tail at the time of the encounter. The sequence of events during this Saturn tail encounter is deduced. (Saturn, Jovian magnetotail, Voyager, radio astronomy, solar wind).
J. Geophys. Res., Blue, Paper 3A1080

5760 Interactions between solar wind and magnetosphere
THE RELATIONSHIP BETWEEN SATURN KILOMETRIC RADIATION AND THE SOLAR WIND
M. D. Desch (Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, MD, 20771), H. O. Rucker
Voyager spacecraft radio, interplanetary plasma, and interplanetary magnetic field data are used to show that large amplitude fluctuations in the power generated by the Saturn kilometric radio emission are best correlated with solar wind ram pressure variations. In all, thirteen solar wind quantities previously found important in driving terrestrial magnetospheric substorms and other auroral processes were examined for evidence of correlations with the Saturn radio emission. The results are consistent with hydromagnetic wave or eddy diffusion processes driven by large scale solar wind pressure changes at Saturn's dayside magnetopause. (Saturn, Voyager, radio astronomy, solar wind).
J. Geophys. Res., Blue, Paper 3A0697

5733 Magnetic Storms
LONGITUDINAL STRUCTURE OF SUBSTORM INJECTIONS AT SYNCHRONOUS ORBIT
B. L. Arnoldy (Space Science Center, University of New Hampshire, 03824), T. E. Moore
From multiple spacecraft measurements, it is shown that the synchronous orbit manifestation of a substorm, i.e., plasma injection and magnetic field reconfiguration to dipolar, has an onset which expands both eastward and westward from a relatively narrow sector near midnight. For low-to-moderate geomagnetic activity, the earliest onset sector at synchronous orbit is about three hours wide, skewed towards the evening side of midnight. Using the extensive IMS ground magnetometer network beneath the satellites, it is found that simultaneous westward motion of electrojet intensification is seen in the ground data over a larger longitudinal range than the magnetospheric signatures. This might be explained in terms of distortion of the nightside magnetic field at synchronous orbit.
Plasma that has already been injected near midnight at synchronous altitude undergoes no further change as a result of the westward and eastward motion of the borders of the plasma. This suggests that the expansion does not represent new substorm activation. One can interpret these results in terms of an injection front wedge which makes hot plasma accessible to the inner magnetosphere and which spatially expands or propagates with time. The origin of plasma behind the front is not addressed. Detailed pitch angle data does, however, show that strong precipitation would be expected from the front for about the first ten minutes after the front passes over an observer.
Finally, as a result of longitudinal expansion of plasma injections from midnight towards evening or morning and the continuation or even enhancement of field inflation in the evening or morning sectors, growth and expansive phase substorm signatures can occur simultaneously. Substorm expansion at midnight can thus be accompanied by continued growth signatures in evening or morning. (Injections, substorms, initiation, particle measurements).
J. Geophys. Res., Blue, Paper 3A0892

5710 Magnetopause
INTERACTION OF RING CURRENT IONS WITH THE MAGNETOPAUSE
M. Scholer (Max-Planck-Institut für Physik und Astrophysik, Institut für extraterrestrische Physik, 8046 Garching, FRG) and F. M. Ipavich
We have analyzed phase space density observations of ring current protons (70 - 130 keV) during a magnetopause crossing of ISEE 1 on July 5, 1978. Plasma and magnetic field data obtained during this crossing have been reported to be consistent with quasi-steady reconnection and a reconnection line south of the satellite

1155 (Plasma Instabilities)
SIMULATION OF THE ION TEARING INSTABILITY IN THE PRESENCE OF A BACKGROUND PLASMA
J.J. Ambrosiano, L.C. Lee (Geophysical Institute, University of Alaska, Fairbanks, Alaska, 99701) and D.W. Swift
A comparison is made between two classes of Vlasov equilibria with respect to the ion tearing mode instability. The first class is that of a current sheet in equilibrium with a vacuum (Harris type). The second class is that of a current sheet in equilibrium with a magnetized background plasma. The comparison is made via a simple magnetoinductive simulation involving

Chapman Conference on Collisionless Shock Waves in the Heliosphere

February 20–24, 1984
Silverado Country Club and Resort
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Abstract Deadline: November 1, 1983

Invited reviews and contributed papers in the following general areas: Overview of the collisionless shock, macroscopic aspects of shocks, microscopic aspects of shocks and particle acceleration. Typical subjects to be covered include:

- Why and where shocks form in the heliosphere?
- Shock dynamics and evolution.
- Shocks associated with solar activity, planetary bow shocks, corotation shocks, and shock-shock interactions.
- Subcritical, supercritical, quasi-parallel, and quasi-perpendicular shocks.
- Dissipation mechanisms.
- The foreshock.
- Particle acceleration mechanisms.

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Physical Properties of Rocks

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